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LONGITUDINAL STUDY THROUGH THE FOURTH GRADE OF LANGUAGE SKILLS OF CHILDREN WITH VARYING SPEECH SOUND ARTICULATION IN KINDERGARTEN. FINAL REPORT.

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This longitudinal study attempts to (1) describe the development of articulation of consonant phonemes through the 4th grade, and (2) explore the relation between articulation and non-articulation variables. Between the spring before kindergarten entrance and the 4th grade, 436 subjects were tested 11 times at 6-month intervals. On the basis of kindergarten measures, boys and girls were selected: One shift sample with scores on imitation and picture articulation tests differing substantially; 5 percentile samples with articulation scores clustered around the 7th, 15th, 30th, 50th, and 98th percentiles on total distributions; and 3 phoneme samples, each with one phoneme as the primary mis-articulation. Articulation was assessed at each session. At selected sessions, tests were administered in the speech, reading, spelling, language, auditory stimuli, visual stimuli, personality, intelligence, and motor areas. Articulation scores of the percentile samples maintained the same relative positions through the study. Adequate articulation was attained by the 98th percentile samples before kindergarten, and had not been attained by the 7th percentile samples in 4th grade. Among the percentile samples, mean non-articulation scores were lowest for the 7th and highest for the 98th percentiles. No pattern of non-articulation scores was identified for the phoneme samples. (Author)

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FINAL REPORT
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February 1968

U. S. DEPARTMENT OF
HEALTH, EDUCATION AND WELFARE

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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Mildred C. Templin

January 1968

The research reported herein was performed pursuant to a contract with the Office of Education, U. S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions do not, therefore, necessarily represent official Office of Education position or policy.

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ACKNOWLEDGEMENTS

A project carried on over a six-year span with children enrolled in over a hundred schools is possible only because many persons have contributed their ideas, enthusiasm and cooperation. Although they cannot be thanked individually, their contributions are known and appreciated. Special thanks are due those whose consultation has been sought and influenced many aspects of the project; to the public and parochial school administrators, the principals and teachers in participating schools for their understanding and cooperation; to the Minneapolis Public School speech clinicians for administering some of the tests; and to the subjects and their parents for participating in the project. The contributions of those who have constructed measures given to the children are credited in the text. The sustained assistance of Mrs. Susan Dettweiler and Mrs. Helen Dickison in the final preparation of the report must be recognized specifically.

My responsibility for the project is accepted with the hope that it may be useful in increasing the understanding of education of children, and that in its strengths and weaknesses other workers may find something of value.

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INTRODUCTION

Current interest in the study of speech and language development is wide-spread, and the importance of such study to both theoretical and applied work in a number of fields is recognized. Results have general relevance for many developmental psychologists, psycholinguists, educators, clinicians and speech therapists; they also have specific relevance for persons concerned with the development and the remediation of speech and language.

Some years ago, a representative sample of nearly 2,000 public school speech clinicians identified, as needed research, the collection of longitudinal data on speech and the development of criteria for selection of primary-grade school children for remedial speech programs (44). Despite this, there has been little study of the development of adequate production of the phonemes of English by the same children during the early school years. Recently research and discussion has focused more on various aspects of the problem of case selection. However, while the relation of articulation performance to other language and language-related skills in the same subjects may have implications for case selection, little intensive or extensive exploration of the relationships has been undertaken.

In 1960, the project director initiated a comprehensive investigation (as USOE Project # 818) that was concerned with several aspects of the high-priority research problems identified by the speech clinicians. It coordinated several studies: a prediction study in which it was attempted to identify in kindergarten children who would need speech therapy in second grade; a longitudinal study of the development of articulation and of its interrelations with certain non-articulation variables; and a number of ancillary studies that tapped the same pool of subjects for the investigation of related problems.

In the large project, articulation of children was first tested in the spring before they were enrolled in kindergarten. Subsequently their performance on articulation and other measures was tested at six-month intervals. Since fewer subjects than had been anticipated from results of cross-sectional studies had achieved adequate articulation after six testing sessions, when most were in second grade, the periodic testing was continued through the fourth grade (as USOE Project # 2220). This report presents analyses of the longitudinal data gathered in eleven testing sessions over a five-year span from prekindergarten through fourth grade. It presents only descriptive data and analyses dealing with gross scores, and withholds for later presentation analyses dealing with more specific aspects of articulation development and with the relation between articulation and non-articulation variables.

Longitudinal studies not only take a long time to carry on, but are expensive in money and energy. Nothing can be done to shorten the time that must elapse between observations of children. Efforts must continuously be made to maintain the sample selected for study. Yet, inevitably, subjects move, become ill, etc., and are lost to the sample as the observations are continued. Not until the final testing is completed can the subjects in the sample to be analyzed be identified. As a result many data that are gathered cannot be used in the analyses. Among the other disadvantages of longitudinal studies that can be pointed out are being bound methodologically to the past, restriction in the use of experimental controls, and limitations forced upon generalization of the results. However, there is no other way than through longitudinal study to obtain information on development of performance of the same individuals, and on possible interrelations among a number of variables over time. Such information in addition to being of basic theoretical significance has particular practical value for the many persons concerned with the growth and well-being of the same children over a period of time, e.g. teachers, clinicians and parents.

Review of Relevant Literature

From the large amount of research relevant to this study, that briefly considered deals with measurement of articulation with and without the presentation of an aural model, with longitudinal studies of articulation development, and with the relations between articulation and non-articulation variables. Literature dealing with specific characteristics of these variables is not reviewed, since it is more pertinent to specific analyses that are planned or completed.

Measurement with and without an Aural Model

Studies that investigate the articulation of phonemes evaluated in words elicited in response to pictures, with no aural model presented, and in words repeated after an aural model have specific relevance because of the method of sample selection used in the longitudinal study. Some ten studies have been previously reviewed and evaluated by the project director (60, 65). All of the studies carried on since the mid-forties reported somewhat higher articulation scores when evaluation was based on an imitative response. However, both statistically significant and insignificant differences have been found; differences are not consistently found for all phonemes evaluated; and actual differences between total scores are not large. Some recent studies have employed more rigid design and control, but have not reported definitive results (50, 61). Samples of children have ranged from young preschool to junior-high school age, from those with essentially normal to severely deviant articulation, and from the intellectually normal to the mentally retarded.

While results from the several studies indicate that the method used to elicit responses may influence the evaluation of the adequacy of phoneme production the identification of the superiority of one method over the other is an individual interpretation related to the purpose of a particular evaluation. The spontaneous method is more likely to elicit a child's typical performance, and the imitative method to elicit his maximal performance.

Divergence in scores of the same subject obtained on the two types of articulation measures have been found associated with more rapid improvement in articulation (10, 53). However, in the prediction study of the present project, a higher proportion of subjects with substantially divergent than with similar scores were identified as needing speech therapy in second grade (60).

Longitudinal Studies of Articulation

There are no studies which describe in detail the development of phonemes in English on a substantial number of children during the early school years. Although the number of longitudinal studies during this period is increasing, they tend to be concerned with the problems of predicting articulation deviation and/or delineating a definition of articulation deviation and do not report specific developmental characteristics of articulation.

In a recent report Templin (60) has reviewed the major studies on prediction. She points out that despite the basic relation of prediction to the task of the speech clinician, research literature on the problem, per se, is relatively recent and not extensive. Only eight studies published between 1954 and 1966 were located and, for the most part, they were relatively insulated from one another. They were concerned with identification of subjects who would improve their articulation production over the years, and with the identification of factors that might differentiate those initially classified as deviant in articulation who did, and did not, improve in their articulation production. For the most part, studies attempted prediction of articulation performance over a relatively short time span (usually one or two years) after initial school experience in kindergarten or first grade. In most studies subjects were considered to have deviant articulation at the initiation of an investigation, but the number of misarticulations that were included under deviant articulation varied greatly. In some studies the number of misarticulations was so small that it is questionable whether the articulation could appropriately be considered deviant even at the early school years. Concerted, long-term investigation is essential for a meaningful attack upon the many-faceted problem of prediction of adequate articulation. The work of Pronovost and his associates (43) and VanRiper (68) is such work.

Recently Wepman and Morency (72) have used the concept of age-appropriate misarticulation as part of their concern with the definition of an articulation deviation during the developmental period. In previous work (35) they found that between the ages of five and nine, the misarticulation profiles of children with non-pathological etiology were characterized by deviant production of the last ten consonant sounds acquired by children according to Templin's normative study. Comparing the performance of 66 subjects with at least six age-appropriate misarticulations with 114 subjects with five or less such misarticulations at first, second, and third grades, they found no significant differences in performance on measures of verbal intelligence, perceptual tasks, and reading. The concept of age-appropriate misarticulation is important for evolving a definition of an articulation deviation in kindergarten since it focuses on the differentiation between slow development and deficient status.

Relation between Articulation and Non-Articulation Variables

The general relation between articulation and other language variables is reasonably well-established. In 1934 Davis (13) reported that the mastery of articulation, as rated on a seven-point scale from perfect to incomprehensible speech, was closely related to other language performance. Templin (63) has reported substantial correlations between articulation test scores and the length and complexity of responses, and a number of vocabulary measures that tended to decrease over the age range from three to eight years. Wepman and Morency (72) recently reported no difference in reading and spelling scores of children with acceptable articulation and those with unacceptable articulation, but with age-appropriate errors, in first, second and third grades.

The extent and nature of the relation between articulation and reading is not known, but the existence of some relation is quite generally accepted. In the thirties, Bond (6) reported that articulation performance did not differ between good and poor silent readers, but did differ between good silent and poor oral readers and between poor silent and good oral readers. In the forties, Artley (2) pointed out that while a relationship between speech difficulties and deficiency in both silent and oral reading seemed to be present, there was no general agreement on the extent of the relationship. In the sixties, Weaver, Furbee and Everhart (69) stated that investigations of the articulation of good and poor readers, and of the reading skill of subjects with and without speech defects seemed to emphasize a concomitant relationship.

The nature of the relationship between spelling and articulation is not firmly established. In the thirties Russell (47) in comparing good and poor spellers reported that poor spellers had more mispronunciations. In the fifties, Carrell and Pendergast (9), however, found no significant differences either in spelling ability or in types of spelling errors when they compared all written school work over a two-month period of subjects with normal and with delayed speech in grades two through five. Ham (19) found that children in these same grades who were receiving speech therapy more frequently mispronounced the words they misspelled than the words they spelled correctly.

A number of studies have been concerned with the effect of speech training and therapy upon the performance of subjects on other language variables. Irwin (26, 27), Sommers and others (54), Weaver et al (69) and Wepman and Morency (72) found no improvement in the various language skills measured when subjects were given speech therapy. Jones (29) reported improvement in silent reading skills for third graders who were given speech training.

A number of other approaches to the question can be identified. For example, deHirsch (14) has attempted the prediction of reading failure on the basis of a number of language variables, including articulation. Zedler (75) found that second-grade subjects given specific auditory training and experience with phoneme-grapheme association improved in written spelling and in sound discrimination over those who did not receive this training.

Several summaries of the research on articulation and non-language variables have been published. In reviewing studies on the relation of articulation and intelligence, Winitz (73) reported that they indicate, in general, low positive correlations between intelligence and the status of articulation, and zero-order correlations between intelligence and articulation improvement. Weiner (71) in a summary of research on articulation defects and auditory discrimination, concluded that, despite criticism of the studies, the following findings had considerable support: the developmental character of auditory discrimination; the better performance of children from the upper-socioeconomic status groups; and the positive relationship between auditory discrimination and more severe articulation deviation at ages below nine years.

Summarizing studies of the relation between articulation and personality, Spriestersbach (56) some years ago stated that the research available was such that no general statement about the relation was justified. A few years later, after summarizing twenty-five years of research on personality as related to functional speech disorders, including articulation, Goodstein (18) came to a similar conclusion. He stated that the methodological and conceptual limitations of the research were so important that few, if any, generalizations were possible.

Many relatively insulated studies have been carried on over the years. Some have been concerned with the articulation performance of groups contrasted on variables such as spelling or reading; some have been concerned with the performance on non-articulation variables of groups contrasted on articulation performance; some have been concerned with the relation of the status and others with the improvement of articulation to other variables. Since most children attain adequate articulation by seven or eight years of age, studies using samples above these ages have been most concerned with deviant articulation, and those with younger subjects with the developmental aspects of articulation or the problem of defining an articulation deviation during the developmental period.

Studies of the relation between articulation and non-articulation performance have been carried on for some four decades. Persons who have systematically reviewed aspects of the research literature have pointed up the lack of conceptualization of the research problems, the limitations of the research methodology, and the wide range of severity of articulation deviation and age in the subjects studied. Investigations do suggest the possibility of stronger relationships existing among those subjects with more extreme articulation deviations. In 1954 Spriestersbach emphasized that a study evaluating the adjustment problems of a sample with severe articulation problems was overdue. Over the years there have been no major, systematic attacks upon the question of the relation of articulation to a number of important non-articulation variables. These, surely, are now long overdue.

The Study

The comprehensive investigation was undertaken with the following objectives:

1. To attempt to identify in prekindergarten and kindergarten those children who will need speech therapy in second grade.

2. To describe the development of consonant phoneme production including consonants in singles and in clusters through the fourth grade or until adequate articulation is achieved.

3. To identify variables which may be related to adequate production of speech sounds by second, third and fourth grade children.

4. To study the relations of language skills over a period of time in the same children.

5. To test hypotheses growing out of analyses of the developmental data in ancillary studies carried on with samples of children selected according to performance on different language measures.

Analysis of the predictive study which is concerned with Objective 1 has been presented as the final report for USOE Project # 818 (60); several ancillary studies which are concerned with Objective 5 will be published in appropriate journals; the longitudinal study is concerned with objectives 2, 3, and 4 and is presented in this report.

METHOD

In the longitudinal study, selected subjects were tested eleven times at six-month intervals. Subjects were prekindergartners at Session 1, in kindergarten at Sessions 2 and 3, in first grade at Sessions 4 and 5, in second grade at Sessions 6 and 7, in third grade at Sessions 8 and 9 and in fourth grade at Sessions 10 and 11. Sessions rather than grades are designated, however, since all subjects did not remain at grade throughout the five years of testing.

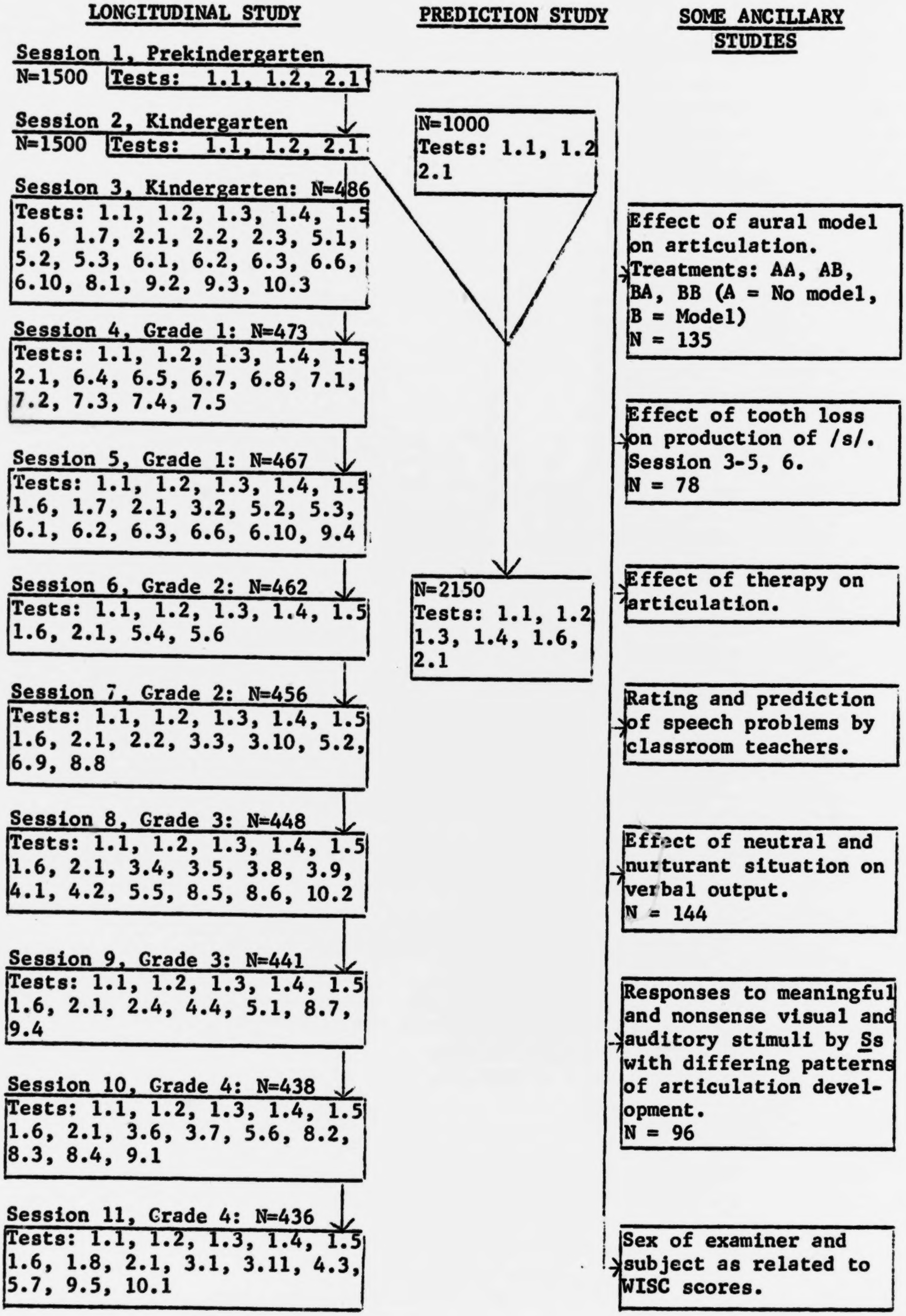
The manner in which the predictive, longitudinal and ancillary studies were integrated and used subjects distinctively is seen in Figure 1. The specific tests administered at each testing session are indicated by number on Figure 1, identified on Table 1, and described in the section, Measures Used.

Sample

Subjects in the samples analyzed were those 223 boys and 213 girls who were selected after Session 2 and were available for testing at Session 11. Criteria for initial selection were related to aspects of articulation considered as probably important for prediction of articulation development and possible definition of articulation deviation in kindergarten.

All subjects were selected from those children whose articulation was tested at Session 1, since information on an additional six months of development was thus made available. At Session 1 the articulation of approximately 1500 subjects was evaluated using the 1.1 Prekindergarten Picture Articulation Test, and 1.2 Prekindergarten Imitation Articulation Test (described in the section, Measures Used). At Session 2 the articulation of these children was retested and that of another 1000 children from the same kindergarten classrooms was tested using the same tests. Total scores of all subjects, boys or girls, who had and had not been tested at Session 1 did not differ significantly at Session 2 on either test.

Aspects of articulation considered in the selection of subjects were: (1) Whether or not articulation scores of the same subject differed when based on evaluations in words elicited by pictures with no aural model, and by imitation with an aural model presented by the examiner; (2) the total number of misarticulations; and (3) the specific phonemes misarticulated. Using statistical procedures that took into account the consistency of test scores of individuals and the distributions of scores on both imitation and picture prekindergarten tests, nine study samples were chosen. Both boys and girls were selected on the distributions for their own sex.



Session 1, Prekindergarten
N=1500 Tests: 1.1, 1.2, 2.1

Session 2, Kindergarten
N=1500 Tests: 1.1, 1.2, 2.1

Session 3, Kindergarten: N=486
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
1.6, 1.7, 2.1, 2.2, 2.3, 5.1,
5.2, 5.3, 6.1, 6.2, 6.3, 6.6,
6.10, 8.1, 9.2, 9.3, 10.3

Session 4, Grade 1: N=473
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
2.1, 6.4, 6.5, 6.7, 6.8, 7.1,
7.2, 7.3, 7.4, 7.5

Session 5, Grade 1: N=467
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
1.6, 1.7, 2.1, 3.2, 5.2, 5.3,
6.1, 6.2, 6.3, 6.6, 6.10, 9.4

Session 6, Grade 2: N=462
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
1.6, 2.1, 5.4, 5.6

Session 7, Grade 2: N=456
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
1.6, 2.1, 2.2, 3.3, 3.10, 5.2,
6.9, 8.8

Session 8, Grade 3: N=448
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
1.6, 2.1, 3.4, 3.5, 3.8, 3.9,
4.1, 4.2, 5.5, 8.5, 8.6, 10.2

Session 9, Grade 3: N=441
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
1.6, 2.1, 2.4, 4.4, 5.1, 8.7,
9.4

Session 10, Grade 4: N=438
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
1.6, 2.1, 3.6, 3.7, 5.6, 8.2,
8.3, 8.4, 9.1

Session 11, Grade 4: N=436
Tests: 1.1, 1.2, 1.3, 1.4, 1.5
1.6, 1.8, 2.1, 3.1, 3.11, 4.3,
5.7, 9.5, 10.1

N=1000
Tests: 1.1, 1.2
2.1

N=2150
Tests: 1.1, 1.2
1.3, 1.4, 1.6,
2.1

Effect of aural model on articulation.
Treatments: AA, AB, BA, BB (A = No model, B = Model)
N = 135

Effect of tooth loss on production of /s/.
Session 3-5, 6.
N = 78

Effect of therapy on articulation.

Rating and prediction of speech problems by classroom teachers.

Effect of neutral and nurturant situation on verbal output.
N = 144

Responses to meaningful and nonsense visual and auditory stimuli by Ss with differing patterns of articulation development.
N = 96

Sex of examiner and subject as related to WISC scores.

Figure 1. Flow chart for longitudinal, prediction, and ancillary studies.

Table 1. Measures by Category and Session Administered

TESTS	SESSIONS										
	1	2	3	4	5	6	7	8	9	10	11
1. ARTICULATION MEASURES											
1.1 Prekindergarten Picture	X	X	X	X	X	X	X	X	X	X	X
1.2 Prekindergarten Imitation	X	X	X	X	X	X	X	X	X	X	X
1.3 Kindergarten Picture	-	-	X	X	X	X	X	X	X	X	X
1.4 Kindergarten Imitation	-	-	X	X	X	X	X	X	X	X	X
1.5 Long Articulation	-	-	X	X	X	X	X	X	X	X	X
1.6 Spencer Nonsense Word	-	-	X	-	X	X	X	X	X	X	X
1.7 Duplicated Repetition	-	-	X	-	X	-	-	-	-	-	-
1.8 Phonemes in Sentences	-	-	-	-	-	-	-	-	-	-	X
2. SPEECH MEASURES											
2.1 Intelligibility Rating	X	X	X	X	X	X	X	X	X	X	X
2.2 Teacher's Rating	-	-	X	-	-	-	X	-	-	-	-
2.3 Speech in Family Relations I	-	-	X	-	-	-	-	-	-	-	-
2.4 Speech in Family Relations II	-	-	-	-	-	-	-	-	X	-	-
3. READING MEASURES											
3.1 Gates Reading Survey	-	-	-	-	-	-	-	-	-	-	X
3.2 Grade 1 Vocabulary Recognition	-	-	-	-	X	-	-	-	-	-	-
3.3 Grade 2 Vocabulary Recognition	-	-	-	-	-	-	X	-	-	-	-
3.4 Letter Sound-Production	-	-	-	-	-	-	-	X	-	-	-
3.5 Word Pronunciation	-	-	-	-	-	-	-	X	-	-	-
3.6 McCullough Phonics	-	-	-	-	-	-	-	-	-	X	-
3.7 McCullough Syllabification	-	-	-	-	-	-	-	-	-	X	-
3.8 Bond-Clymer-Hoyt Locating Elements	-	-	-	-	-	-	-	X	-	-	-
3.9 Bond-Clymer-Hoyt Locating Words	-	-	-	-	-	-	-	X	-	-	-
*3.10 Gates Advanced Primary	-	-	-	-	-	-	X	-	-	-	-
3.11 Homographs	-	-	-	-	-	-	-	-	-	-	X
4. SPELLING MEASURES											
4.1 Iowa	-	-	-	-	-	-	-	X	-	-	-
4.2 Metropolitan	-	-	-	-	-	-	-	X	-	-	-
4.3 Dictation	-	-	-	-	-	-	-	-	-	-	X
4.4 Sound Letter-Production	-	-	-	-	-	-	-	-	X	-	-
5. LANGUAGE MEASURES											
*5.1 Recording	-	-	X	-	-	-	-	-	X	-	-
5.2 Berko Morphology	-	-	X	-	X	-	X	-	-	-	-
5.3 Berko Compound Words	-	-	X	-	X	-	-	-	-	-	-
5.4 Berko Word Usage	-	-	-	-	-	X	-	-	-	-	-
5.5 Sentence Completion	-	-	-	-	-	-	-	X	-	-	-
5.6 Jenkins-Palermo Word Association	-	-	-	-	-	X	-	-	-	X	-
*5.7 Written Composition	-	-	-	-	-	-	-	-	-	-	X

Table 1. Tests and Their Administration by Session (Cont.)

TESTS	SESSIONS										
	1	2	3	4	5	6	7	8	9	10	11
6. AUDITORY STIMULUS MEASURES											
6.1 Spencer Initial Sounds	-	-	X	-	X	-	-	-	-	-	-
6.2 Spencer Rhyming Words	-	-	X	-	X	-	-	-	-	-	-
6.3 Spencer Synthesis of Words	-	-	X	-	X	-	-	-	-	-	-
6.4 Monroe Discrimination	-	-	-	X	-	-	-	-	-	-	-
6.5 Monroe Synthesis	-	-	-	X	-	-	-	-	-	-	-
6.6 Templin Sound Discrimination	-	-	X	-	X	-	-	-	-	-	-
6.7 Harrison-Stroud Matching I	-	-	-	X	-	-	-	-	-	-	-
6.8 Harrison-Stroud Matching II	-	-	-	X	-	-	-	-	-	-	-
6.9 Auditory Memory Span	-	-	-	-	-	-	X	-	-	-	-
6.10 Spencer Nonsense Recall	-	-	X	-	X	-	-	-	-	-	-
7. VISUAL STIMULUS MEASURES											
7.1 Metropolitan Reading Readiness	-	-	-	X	-	-	-	-	-	-	-
7.2 Murphy-Durrell Matching Letters	-	-	-	X	-	-	-	-	-	-	-
7.3 Murphy-Durrell Matching Words	-	-	-	X	-	-	-	-	-	-	-
7.4 Clymer Picture Squares	-	-	-	X	-	-	-	-	-	-	-
7.5 Gates Recognition of Digits, Capital and Lower Case Letters	-	-	-	X	-	-	-	-	-	-	-
8. PERSONALITY MEASURES											
8.1 Bene-Anthony Family Relations	-	-	X	-	-	-	-	-	-	-	-
8.2 Bender-Gestalt	-	-	-	-	-	-	-	-	-	X	-
*8.3 Adjective Check List	-	-	-	-	-	-	-	-	-	X	- @
*8.4 TAT	-	-	-	-	-	-	-	-	-	X	-
8.5 Teacher's Rating	-	-	-	-	-	-	-	X	-	-	-
*8.6 Subject Preference Questionnaire	-	-	-	-	-	-	-	X	-	-	-
*8.7 Process of Drawing-A-Man	-	-	-	-	-	-	-	-	X	-	-
*8.8 Parents' Questionnaire	-	-	-	-	-	-	X	-	-	-	-
9. INTELLIGENCE MEASURES											
9.1 WISC	-	-	-	-	-	-	-	-	-	X	- @
9.2 Ammons Picture Vocabulary	-	-	X	-	-	-	-	-	-	-	-
*9.3 California Test of Mental Maturity	-	-	X	-	-	-	-	-	-	-	-
9.4 Goodenough-Harris Draw-A-Man	-	-	-	-	X	-	-	-	X	-	-
9.5 Porteus Mazes	-	-	-	-	-	-	-	-	-	-	X
10. MOTOR MEASURES											
10.1 Stambak Rhythm Test	-	-	-	-	-	-	-	-	-	-	X
10.2 Rating of Handwriting	-	-	-	-	-	-	-	X	-	-	-
10.3 Speech Mechanism	-	-	X	-	-	-	-	-	-	-	-

@ Administered between Sessions 9 and 10.

* Not included in analyses; test described in Appendix C.

One shift sample was made up of those subjects among the children tested at Sessions 1 and 2, whose picture and imitation articulation scores differed by four or more centile points. All subjects located who differed to this extent, and who were not excluded on the basis of other criteria for sample selection, were included in the shift sample. The range of total scores for Test 1.2, Session 2 was from 11-42 for boys and from 17-46 for girls.

Five percentile samples clustered around the 7th, 15th, 30th, 50th, and 98th percentiles of total score distributions. For each sample, 35 to 45 boys and girls were identified as potential subjects because of the consistency and range of their imitation and picture scores. Ranges in total scores on Test 1.2, Session 2, do not overlap for the several percentile samples, boys and girls:

Sample	Boys	Girls
7th percentile	9-23	12-27
15th percentile	25-30	29-34
30th percentile	31-36	35-40
50th percentile	37-44	42-44
98th percentile	-46-	45-46

According to cross-sectional normative data, articulation of the 7th percentile samples resembles that of 3½ year-old children; articulation of the 98th percentile samples approximates that of 7 or 8 year-old children; and articulation of the 50th percentile samples is typical for children in kindergarten.

Three phoneme samples were identified, in each of which misarticulation of either the /r/, /l/ or /s/ was the single major misarticulation, e.g. while the /r/ was misarticulated in nearly all evaluations, the /l/ and /s/ were never or infrequently misarticulated. Six evaluations of each phoneme were available on Tests 1.1 and 1.2 at Session 2.

In selection of the samples, the percentages of correct utterance of each phoneme on each test was first determined. Criteria for stability of misarticulation were established so that, in effect, a child was included as a potential subject for a phoneme sample if he misarticulated that phoneme on at least 83 per cent of the evaluations and misarticulated the other two phonemes on no more than 17 per cent of the evaluations. About 200 potential subjects were identified for the /s/ phoneme samples, and approximately 80 for the /r/ phoneme samples. However, only 18 boys and 5 girls were identified as having single /l/ phoneme misarticulations according to the criterion. Therefore, the number of subjects in the /l/ phoneme sample, boys, is smaller than for other samples, and there is no /l/ phoneme sample, girls, since several of the few girls moved out of the area before Session 11. The specific phonemes selected constitute the major portion of articulation therapy loads of public school speech clinicians. The ranges of total scores on Test 1.2 at Session 3 are:

Samples	Boys	Girls
/r/ phoneme	28-43	33-43
/l/ phoneme	27-41	-----
/s/ phoneme	29-42	26-43

Children who were identified as having organic deviations related to articulation such as hearing loss, malformation of the speech mechanism or known mental retardation were eliminated from the pool of potential subjects. After this, subjects for the final study samples were chosen using a technique of random selection. All subjects were given a sweep check audiometer test as part of the Minneapolis Public School program or by the Minneapolis Division of Public Health.

The prekindergarten children who were tested at Session 1 were enrolled the following fall in 45 Minneapolis elementary schools widely distributed geographically throughout the city and representing all socioeconomic levels. As the study continued subjects were followed to whatever schools they attended within a radius of about 25 miles from Minneapolis. At Session 11 subjects were enrolled in 131 schools: 52 Minneapolis public schools, 47 suburban public schools, and 32 parochial or private Minneapolis and suburban schools.

The schools in which subjects were originally enrolled were not selected according to any identifiable bias. A letter describing the project and inviting participation in it was sent over the signatures of the project director and the Director of Special Education in the Minneapolis Public Schools to the principals of the 74 elementary schools. In response to the letter all except ten of the schools were made available for testing. These ten schools were unable to participate because of limited space, problems of scheduling access to children not yet attending school, or previous commitments to other studies. However, because of limitations of time and project personnel, it was not possible to test in all schools that were available for the initial testing. Those 45 schools in which Session 1 testing was carried on were selected only because it was possible for them to provide children and space for testing them at times that would fit into the schedules of the project speech clinicians.

Children were brought for Session 1 testing by their parents who had received a single page statement indicating the purpose of the study and stating that children with good and poor speech were needed for the study and that speech therapy was not included as part of it.

Through cooperation of the participating schools speech therapy was withheld from all subjects through the second grade. After this, therapy was given but it varied according to the practice of the particular school system in which a subject was enrolled.

The final samples were made up of all 436 subjects tested at Session 11. No subjects were dropped because of identification of hearing loss, enrollment in speech therapy during the course of the study, or because they were not in fourth grade at Session 11. Articulation scores of such subjects fell well within the range of articulation scores for their particular samples. One subject was identified with a hearing loss sufficient to be classified as hard-of-hearing. Fifty-seven children who had received some speech therapy between Sessions 3 and 11 were located through searching school records and obtaining responses to direct questions from parents and school speech clinicians. They included boys and girls in each sample except the 98th percentile samples. Through Session 6 only five subjects had received as much as ten hours of speech therapy, and the amount of therapy received by subjects after Session 6 is not known. Only 36 subjects, 22 boys and 14 girls were not in fourth grade. Of these 6 were in special classes, 28 were in third grade and 2 were in fifth grade. Subjects were below grade in all except the 98th percentile samples. Those samples in which three or more subjects were below grade were the 7th and 30th percentile and the shift samples for boys, and the 7th percentile and the shift samples for girls.

No subjects were dropped from the analyses because of incomplete data. Over the eleven sessions, 15 different subjects were not tested at one session, ten subjects had between two and five missing or invalid tests, and 47 had one missing or invalid test. The method of handling incomplete data is described in the Method of Analysis section.

The study samples decreased by 50 subjects, 29 boys and 21 girls, from the number tested at Session 3 to the number tested at Session 11. (See Figure 1 for the actual number tested at each session.) Subjects were lost from all samples and between all testing sessions: 44 moved out of the area; five were withdrawn-three at parents' and one at the school principal's request, and one because of illness; and one was lost track of temporarily.

Information on the characteristics of each sample at Session 1 is presented in Table A-1: means and standard deviations for CA, WISC Full Scale IQ, number of siblings, position in family and mode of socioeconomic status of their fathers. On the whole the samples are quite similar, but some differences do occur. Socioeconomic status was classified on the Hollingshead Two-Factor Index which takes both occupation and education into account (25). The mode for most samples, boys and girls is Class 4. The one exception for boys and three for girls are either Class 3 or Classes 3 and 4.

On the other variables the range of means for the percentile samples nearly encompass the means for the shift and phoneme samples, both sexes. Ranges in mean scores for all samples are:

	Boys	Girls
CA	56.94-60.21	56.83-59.96
WISC Full Scale IQ	95.15-112.58	93.85-111.11
Position in Family	1.94-2.80	2.43-3.19
Number of Siblings	2.71-3.82	3.36-4.08

Within the percentile samples the means on all background variables tend to differ between the 7th and the 98th percentile samples, boys and girls. For both sexes, the differences are not statistically significant on position in family or number of siblings, but do reach the .01 level of confidence on WISC Full Scale IQ's for both sexes, and on CA for girls. That the mean ages for the samples have the same relation throughout the study is seen in the comparability of the number of months between consecutive testing sessions for all samples (see Table A-2). IQ's on all intelligence tests administered are presented in Table A-3.

Measures Used

The measures used have been grouped under ten headings, such as articulation, speech, and reading primarily for convenience in dealing with a large number of tests and should not be considered as representing distinct categories. They were selected or developed after consultation with experts in the several areas, e.g. the articulation tests were developed after consultation with speech pathologists at the University of Minnesota, the University of Iowa and the Minneapolis Public Schools; spelling and reading measures were selected and developed in consultation with experts at the University of Minnesota and the University of Chicago.

A number of tests that were administered do not enter into the analyses because not all subjects were tested, or because categorical or no scores were available. These excluded tests are listed below and are briefly described in Appendix C since they will be used in presentations of additional analyses of the longitudinal data.

1. Tests excluded because of incomplete data:

    3.10 Gates Advanced Primary Test, Session 7
    9.3 California Test of Mental Maturity, Session 3

2. Tests excluded because only categorical scores were available:

   8.3 Adjective Check List, between Session 9 and 10
   8.6 Subject Preference Questionnaire, Session 8
   10.3 Evaluation of the Speech Mechanism, Session 3

3. Tests excluded because they are not scored:

   5.1 Recording, Session 3 and 9
   5.7 Written Composition, Session 11
   8.4 Thematic Apperception Test (TAT), Session 10
   8.7 Process of Drawing-a-Man, Session 9
   8.8 Parents' Questionnaire, Session 7

For all tests included in the analyses quantitative scores have been used. Descriptions of the 55 tests and the specific scores used in the analyses are presented in this section. Measures devised specifically for use in this study were constructed by the project director if no other person has been credited.

1. Articulation Measures

Articulation was measured in spontaneous and imitative responses to English words, in imitative responses in nonsense words, and in spontaneous responses in sentences. Scores on the Test 1.1 in which sounds were evaluated in words elicited spontaneously were used for sample selection. When the same sounds were evaluated in words spontaneously elicited and repeated after the examiner (Tests 1.1, 1.2 and 1.3, 1.4) only scores based on the latter are used in the analyses because correlations between spontaneous and imitative scores on the same subjects are above .90 (64), and because imitative scores consistently are based upon the evaluation of essentially all of the test sounds.

1.1 Prekindergarten Picture Articulation Test. Sessions 1 through 11. This test consists of 47 sound items evaluated in 29 words elicited spontaneously in response to pictures with no aural model presented. The sound items were selected on the basis of performance of the 4-and 4½-year-old subjects in Templin's normative study (63). In this study 60 children, equally divided between boys and girls, were selected to form a representative sample according to their fathers' occupations and were tested at each half-year level between three and five years and at each year level between five and eight years.

The test includes all consonants uttered by fewer than 92 per cent of the 4- and 4½-year-old children in the normative sample, selected /s/, /l/ and /r/ clusters and /l̩/ and /ʒ/. Phonemes tested in both initial and final positions were:

/θ/, /s/, /ʃ/, /v/, /ð/, /z/, /r/, /l/, /tʃ/, /dʒ/; phonemes tested in the initial position only were: /h/, /w/, /hw/, and /j/; phonemes tested in the final position only were: /m/, /n/, /ŋ/, /p/, /t/, /k/, /b/, /d/, /g/, /f/; the /s/ in initial clusters /sm/, /st/, /sl/, /str/; the /l̩/ and the /l/ in clusters /fl/, /gl/, /sl/; the /ɝ/ and the /r/ in clusters /tr/, /br/, and /str/. The sounds tested and the words in which they were evaluated are given in Appendix B.

For each sound item, the examiner indicated whether the child's production had been accurate, and, if not, whether the sound had been omitted, or inaccurately produced. In Sessions 1 and 2 specific misarticulations were not transcribed, but beginning with Session 3, and from then on, they were transcribed using the International Phonetic Alphabet. If accurate transcription of the misarticulation was not possible, previously agreed upon symbols were used to indicate a distortion or an approximation of the expected phoneme. The examiner watched the child produce each sound evaluated so that both auditory and visual cues were taken into account. If the examiner had difficulty in evaluating an utterance, the child was asked to repeat the word, to speak more loudly, to look at the examiner, etc. If the examiner was still uncertain of the adequacy of the production of a sound it was considered incorrect.

The maximum possible score for the total test was 46. The /hw/ was not counted because it was the only item on which correct production did not increase with age in Templin's normative study.

1.2 Prekindergarten Imitation Articulation Test. Sessions 1 through 11. The sound items were identical with those of Test 1.1 but aural models rather than pictures were used to elicit responses. The examiner said to the child, "Say these words after me," proceeding in order through the list of test words. The words in which the sounds were evaluated were the same for Sessions 1 and 2 but differed in some instances from Session 3 because this test was given as part of the Test 1.5 Long Articulation Test. The sounds and the words in which they were evaluated are given in Appendix B.

The maximum possible scores used in the analyses were: total score, 46, total consonant score, 34, initial consonant score, 13, final consonant score, 21, and total cluster score, 12.

1.3 Kindergarten Picture Articulation Test. Sessions 3 through 11. To permit an evaluation of all consonant phonemes in the initial and final positions in syllables, the nine initial phonemes that had been omitted from the Prekindergarten Articulation Tests (1.1 and 1.2) were added: /m/, /n/, /p/, /t/, /k/, /b/, /d/, /g/, /f/. See Appendix B for a list of all test sounds and the words in which they were evaluated. The examiner followed the same procedure in administering and recording the evaluations of the sound utterances as was described in Test 1.1 beginning with Session 3. The maximum score is the same as for Test 1.4 which is used in the analyses reported.

1.4 Kindergarten Imitation Articulation Test. Sessions 3 through 11. The sounds tested in this test were the same as for the Kindergarten Picture Articulation Test (1.3) but the sounds were evaluated in imitated rather than spontaneous utterances. The words in which the sounds were evaluated are presented in Appendix B. The maximum total score is, 55.

1.5 Long Articulation Test. Sessions 3 through 11. Initial and final two and three consonant clusters, and /l̩/, /ɚ/ and /ɝ/ were evaluated in an imitation articulation test. The consonant clusters measured appear in the initial or final position of English words, the /ɚ/ and /l̩/ in the final position following a consonant, and the /ɝ/ preceding a final consonant or consonant cluster. The sound elements were evaluated in words selected from personal experience, word lists, children's books and other tests to be as familiar as possible to children. For sound elements and stimulus words see Appendix B. Procedures followed were similar to those previously described for Session 3 and following.

In this analysis only a cluster score, the number of correct utterances of the sound elements tested is used. The maximum score is 248. However a total score composed of the 1.5 cluster score and 1.4 total consonant score was computed and mean scores by session and sample are presented in Appendix Table A-13.

1.6 Spencer Nonsense Word Articulation Test. Sessions 3 through 11. Spencer (55) devised this test to measure the child's ability to produce the initial and final consonant phonemes, vowels and diphthongs of English in nonsense words repeated after the examiner. With the exception of r æʒə all word stimulus words are single syllables. In this exception, the /ʒ/, although within the word, is considered an initial consonant because it initiates a syllable. The examiner used the same system of recording and transcribing the child's utterance as previously described as used after Session 3. Test words appear in Appendix B.

The maximum of scores used are: total consonant score, 44, initial consonant score, 23, final consonant score, 21.

1.7 Duplicated Repetition Test. Sessions 3 and 5. The test was devised to determine whether repeated aural presentation of a word results in a shift to correct production of a particular misarticulated phoneme in it, and, if so, at what point in the series of repetitions correct articulation would occur.

The test evaluates utterances of /s/, /l/, or /r/ as consonant singles, parts of consonant clusters or as syllabic sounds in 26 words. The specific phonetic contexts in which the sounds occur were selected on the bases of (1) the expectancy of 28 to 53 per cent of correct utterance at five years of age (63), and (2) the possibility of the desired phonetic context appearing in words rated A or AA on the Thorndike-Lorge Word List (67) or known from experience to be familiar to children (e.g., buckle or splash). The stimulus words with the test elements underlined appear in Appendix B.

In the administration of the test, the examiner said to the child, "This is a repeating game. I'm going to say some words and I want you to say them after me exactly as I say them. Sometimes I'll say the same word over and over and sometimes I'll say the word only once and then say a different one. It doesn't matter. I want you to always say the word that I say exactly as I say it." A few words that contained no test sound elements were used for practice. The examiner said each stimulus word a varying number of times: either until the child said the sound element(s) tested correctly, or until he had made seven incorrect utterances. In order that the repetition of a stimulus word would not become associated with misarticulation of a sound, a stimulus word was repeated several times after three consecutive stimulus words had been produced with no misarticulation of the sound elements. When only one phoneme was misarticulated (e.g., /s/) stimulus words in which this phoneme was not tested were repeated several times.

In order to obtain quantitative scores, each sound element tested was assigned a value: either the number of repetitions of the stimulus word necessary for the test sound element to be correctly articulated, or 8, if it was never articulated correctly. Sums of the assigned values were used to obtain scores, with maximums as follows: 64 for /r/, 56 for /l/, 48 for /s/, and 168 for the total test. A low score is associated with good articulation.

1.8 Phonemes in Sentences. Session 11. The sentences used in Test 3.11, Pronunciation of Homographs, also provide for the evaluation of the articulation of /r/, /l/ and /s/ in words read aloud in sentences. In each of the 18 sentences one of the sounds is used in three or four words. The sentences are presented in Appendix B under Test 3.11, and the construction of the sentences is described on page 22. Adequacy of articulation is indicated by the number of correct productions of the sound, with maximum scores as follows: 18 for /r/, 18 for /l/, 18 for /s/, and 54 for the total test.

2. Speech Measures

Two aspects of speech are included: (1) evaluations of the general speech production of the subjects; and (2) evaluations by each subject of his speech and language environment. Additional information on speech development and performance is available in the questionnaire filled out by parents.

2.1 Intelligibility Rating. Sessions 1 through 11. Intelligibility was defined as how well a child could be understood when no attention was paid specifically to voice quality, rate, pitch, or any other particular speech characteristic. The examiner rated the subject on the basis of conversation carried on before any testing at each session. Rating was on a three point scale: 1 if the examiner had no difficulty understanding the subject; 2 if he had some difficulty; and 3 if he had considerable difficulty. The procedure was adapted from the work of Sherman and her associates. The ratings are respectively comparable to approximate ratings of 1, 2 of 3, 4, 5 and of 6, 7, 8, 9 on the Sherman-Morrison Scale (36, 48, 49).

2.2 Teacher's Rating. Sessions 3 and 7. The degree of speech deviation of each subject and the extent of its handicapping effect upon his school performance was rated by kindergarten and second grade teachers. The instructions given the teachers clearly differentiated "deviation" as referring to the degree of variation from adequate speech for children in a given grade, and "handicap" as referring to the effect of the speech deviation upon the subject's adjustment in kindergarten or his school work in second grade. Both deviation and handicap were rated as none, slight, moderate or extreme, and scored 0, 1, 2, and 3 respectively.

2.3 Speech in Family Relations I.[1] Session 3. The subject's emotional attitude toward various kinds of speech behavior within his family environment was assessed in 20 statements constructed to follow the pattern and form of the messages in the Bene-Anthony Family Relations Test for Younger Children (described as Test 8.1 on page 31). The messages express positive or negative feelings coming to or going from the subject. Each message was associated by the subject with one or more of the figures he selected to represent all members of his family plus "Nobody." An example of a negative message coming from the subject is: "N...(Subject's name) doesn't like to talk to you because you don't listen. Who doesn't listen to N...?" An example of a positive message coming to the subject is: "You like to listen to N. Who likes to listen to N...?" The 20 messages dealing with speech behavior are presented in Appendix B. They were typed on cards, shuffled, and presented to the subjects along with the Bene-Anthony messages.

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[1] Constructed by Dorothy Huseby, Mary Hartwell, and Mildred C. Templin.

A quantitative score for the speech messages was obtained by summing the number of positive messages - either incoming or outgoing - the subject associated with members of his family and the number of negative messages - either incoming or outgoing - he associated with "Nobody." The maximum score is 20.

2.4 Speech in Family Relations II.[2] Session 9. The 40 statements used in this test follow the pattern of positive and negative messages in Test 2.3, Speech in Family Relations I, but the content was designed for third grade children. In all statements the form of the Bene-Anthony Family Relations Test for Older Children was followed, and "This person" rather than the subject's name was used. An example of positive feeling coming from the subject is: "This person in the family likes to read to others." An example of negative feeling coming to the subject is: "This person in the family sometimes makes fun of the way I talk."

The one major modification in the administration of this test was the addition of a figure for "Everybody" to those of the identified family members and "Nobody" since a number of statements relate to possible general family activity. The 40 statements are in Appendix B.

The score is the sum of the number of all positive statements the subject associated with members of his family and "Everybody" and the number of negative statements he associated with "Nobody." The maximum score is 40.

3. Reading Measures

Measures of reading and of some techniques associated with reading skill are included both in published tests and in instruments constructed for use in this study.

3.1 Gates Reading Survey (1960 Revision). Session 11. The survey (17) consists of three tests. (1) The Speech and Accuracy Test contains 36 paragraphs each with a comprehension exercise to determine whether it has been understood. The test is timed, and the number of exercises correct is the speed of reading score, maximum 36. (2) The Vocabulary Test is made up of 65 items arranged in order of increasing difficulty. Each item presents a key word accompanied by five other words from which the one whose meaning is nearest that of the key word is chosen.

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[2] Constructed by Rhoda Olsrud Mackenzie and Mildred C. Templin.

The score, maximum 65, is determined by the number of correct responses minus one-fourth the number of wrong responses. (3) The Level of Comprehension Test consists of 21 passages arranged in order of increasing difficulty. The score is the number of correct responses minus ½ the number of wrong responses, with a maximum of 21. The sum of the Speed, Vocabulary and Comprehension scores constitute a total score, maximum 122.

3.2 Grade One Vocabulary Recognition.[3] Session 5. This test was made up of 106 words selected from the vocabulary in the first grade reader of Scott Foresman (45) after eliminating proper names and then employing a random numbers technique. The list of words (see Appendix B) was given the subject and he was asked to read the words aloud while the examiner noted his response to each word as (1) word correctly read, (2) no attempt made to read the word, and (3) word incorrectly read, with the subject's exact reading attempt recorded. The score is the number of words read correctly, maximum score 106.

3.3 Grade Two Vocabulary Recognition.[4] Session 7. The purpose, procedure, and scoring of the reading of the 100 words selected from the second grade reader of the same reading series (46) was similar to those for Test 3.2. The second grade words are presented in Appendix B. The maximum score is 100.

3.4 Letter Sound-Production Test.[5] Session 8. This test was devised to determine whether a child could associate an acceptable phoneme with the isolated letter(s) presented visually. The letters representing the consonant phonemes and the vowel graphemes of English are: M, N, P, T, K, B, D, G, F, TH, S, SH, V, Z, WH, CH, R, L, H, W, J, A, E, I, O, U, C, Q, X, Y, NG. The examiner said to the subject, "Here are some letters. I want you to tell me what sounds these letters make." (Pointing to the first letter), "What is the sound of this letter?" The examiner continued to obtain the subject's response to all items on the list. He transcribed the subject's response to each item using the International Phonetic Alphabet. A response was considered correct if it was a phoneme that could reasonably be associated in American English with the letter or letters on the list. The maximum score is 31. Maximum for consonant and vowel subscores are 26 and 5 respectively.

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[3] Constructed by Gian P. Jain and Mildred C. Templin.

[4] Constructed by Gian P. Jain and Mildred C. Templin.

[5] Constructed by Ronald J. Johnson and Mildred C. Templin.

3.5 Word Pronunciation Test.[6] Session 8. The test was designed primarily to identify the technique or techniques of word recognition that a child uses when attempting to pronounce probably unfamiliar words presented out of context. The test consists of five polysyllabic words (paper, downfallen, interest, conductor, superstition) each typed on a 3 x 5 card presented singly to be read aloud. Subjects were encouraged to make all attempts at pronunciation orally, and the examiner recorded all such attempts for each word. After the attempts at pronunciation of the five words had been completed, the examiner recorded his impression of the most prevalent characteristics of the child's overall performance by checking appropriate items on a check list containing items such as: depends mainly on general appearance of a word; recognizes at sight familiar parts - root words, parts of compound words, etc.; analyzes syllables, phonograms or other meaningful units phonetically; depends mainly on sounding individual letters; depends mainly on naming individual letters.

In this report, however, two quantitative scores are used: (1) the number of words pronounced correctly on the first attempt, maximum score 5; and (2) the number of words pronounced correctly regardless of the number of attempts, maximum score 5.

3.6 McCullough Phonics Test. Session 10. This test is Test IV, Sounding Whole Word Test, in the McCullough Word Analysis Tests (32). It assesses the ability of a subject to identify consonant and vowel sounds and to blend them into whole words. Although it was designed for use in the fifth grade, in this study it was administered to subjects who, if they were at-grade, were in fourth grade. The test consists of 30 test items, each of which consists of three strange words and a broken line; e. g. dran, ghan, trak, ---. None of the words are correctly spelled English words, but some of them could be English words if the subject were aware of the sounds associated with the letters. The examiner said to the subject: "This is a test of your ability to sound out strange words. Sound out to yourself the words in each row. If one of them sounds like a word you have heard and know the meaning of, put a cross on it. If no word in the row sounds like one you know put a cross on the blank at the end of the row." The examiner worked through a practice item with the subject to be sure that he understood the procedure. The score is the number of correct items. Maximum score is 30.

3.7 McCullough Syllabification Test. Session 10. This test is Test V, Dividing Words in Syllables Test, in the McCullough Word Analysis Tests. It is composed of 30 test items in each of which the child is to syllabify a two-syllable word according to one of eight rules. The test was designed for fourth graders, and was administered to subjects who, if at grade, were in fourth grade. The examiner read the instructions: "This is a test of your ability to divide words into syllables. Each word in the test contains two syllables. Think what the two syllables in the words are. Draw a line between the two parts of the word." A practice item as given the child who was then told to "complete the test in the same way." In this report the score used is the total number of words correctly syllabified, maximum score, 30.

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[6] Constructed by Ronald J. Johnson.

3.8 Bond-Clymer-Hoyt Locating Elements in Words. Session 8. This test, Test 7 in The Developmental Reading Test of Bond, Clymer and Hoyt (7) is designed to measure the child's knowledge of the sound of elements within words. In each of 30 items, five different combinations of letters representing parts of English words are presented, and for each item the subject encircles the combination that represents what the examiner has read to him. For example, when the examiner says the combination cen (as in center) the subject is to encircle this combination in the following five that are presented: con, kom, son, nuc, cen. One point is given for each correct response, and the maximum score is 30.

3.9 Bond-Clymer-Hoyt Locating Words in Words. Session 8. This test, Test 4 in The Developmental Reading Tests by Bond, Clymer and Hoyt is designed to measure the subject's ability to locate parts of words which are useful in word recognition. It is composed of 36 items in each of which a picture is presented with a word under it, and the child is to encircle within this word the shorter word the picture shows. For example, the word fancy appears under the picture of a fan, and the word entirely under the picture of a tire. One point was given for each correct item, and two quantitative scores were obtained: (1) the number of items correctly completed within five minutes; and (2) the number of items correctly completed with no time limitation. The maximum score for both is 36.

3.10 Gates Advanced Primary Reading Test. Session 7. See Appendix C.

3.11 Homographs.[7] Session 11. This test was devised to determine the frequency of correct accent of homographs, the level of difficulty in orally reading specific sentences, and the adequacy of articulation of /s/, /l/ and /r/ in sentences. The test consists of 18 sentences to be read aloud. They were constructed so that one of nine pairs of homographs was used in each sentence and 18 evaluations of each of the three phonemes were made (See Test 1.8). The homographs (e.g. pro'ject - project' and con'tent - content') included were suggested by the work of Dr. Richard Hodges (24) and were specifically selected because of the high frequency of their use according to the Thorndike-Lorge Word List (67) or their liklihood of being familiar to present-day children. Each sentence was typed on a separate 4 x 6 card and presented to the child to be read aloud (see Appendix B for complete list).

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[7] Constructed by Sylvia Rosen and Mildred C. Templin.

For each homograph the examiner recorded whether the accent was correct or incorrect and, if incorrect, checked such characteristics of its pronunciation as shift of accent, repetition or hesitancy. In this report, however, only the number of sentences in which the homograph is pronounced correctly is used as the quantitative score, maximum, 18.

For each sentence, the examiner rated the level of difficulty the subject exhibited in reading the sentence as a whole as none, slight, or considerable. No difficulty was coded as 0, slight difficulty as 1, and considerable as 2. Based on the assumption that each category could be considered a weight, a weighted score was obtained by summing the products of each weight (0, 1, and 2) and the number of sentences in which the weight was assigned. A higher score indicates greater difficulty in reading these sentences. The maximum weighted score for reading sentences is 36.

4. Spelling Measures

To test spelling two types of measures are included: (1) dictation, in which the subjects spell both English words and nonsense combinations using the sounds of English, and (2) proofreading, in which subjects are to identify spelling errors that appear in printed words.

4.1 Iowa Recognition Spelling Test. Session 8. This test is taken from the Iowa Tests of Basic Skills (31) and is designed to measure the subject's ability to recognize words spelled incorrectly. The test consists of 31 items in which five choices are presented: the first four are words, any of which may be misspelled, and the fifth is always No Mistakes. The subject is to find any misspelled words or to indicate that there are no spelling errors. Two scores are obtained: (1) the total number of correct items, maximum score 31; and (2) a score based on correction for guessing in which the maximum is also 31.

4.2 Metropolitan Spelling Test. Session 8. The order of the 40 words in the Metropolitan Spelling Test (33) was rearranged[8] from the easiest to the hardest. Words were dictated to the subjects following the procedure for the administration of the Metropolitan

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[8] Rearranged by Ronald J. Johnson with permission from publisher.

Spelling Test in which the word is dictated, used in a sentence, and dictated a second time. The score is the total number of words spelled correctly, maximum score, 40.

4.3 Dictation Test.[9] Session 11. The test consists of 20 dictated words selected to apply five rules of spelling taken from the work of Hodges and associates (23, 24) that relate to pluralization and the spelling of certain sounds in varying contexts. The procedure followed is similar to that of the Metropolitan Spelling Test. The words and the sentences in which they are used are presented in Appendix B. Two quantitative scores are obtained and used in this report: (1) the number of words in which the particular rule tested is correctly applied, maximum score, 20; and (2) the number of words spelled correctly, maximum score, 20.

4.4 Sound Letter-Production Test.[10] Session 9. This test was designed to permit the subject to furnish the letters that typically represent the consonant sounds used in 23 nonsense consonant-vowel-consonant combinations dictated by the examiner. In the combinations, the same vowel is used throughout, and each consonant phoneme is presented in the initial and final position if it appears in these positions in English words. The combinations dictated are: midʒ, niʒ, pim, tid, kif, biv, diθ, gik, fið, θip, siʃ, ʃib, vir, ʒil, zin, ʍis, tʃif, dʒit, riz, liŋ, hig, wib, jit.

In administering the test, the examiner said to the subject, "I want you to write some words for me. These aren't real words, but they have the same sounds in them as some real words do. Listen carefully to the word I say, and then write it the way you think it would look. I'll give you a hint. The second sound in each of these words is in i. The first word is midʒ. Remember, when you write the word, the middle sound will always be an i." Each combination is said twice for the subject.

In the quantitative scores used, each consonant sound spelled correctly is counted one point. The scores are: (1) initial consonant sounds spelled correctly, maximum score, 23; (2) final consonant sounds spelled correctly, maximum score, 23; and (3) total number of consonants spelled correctly, maximum score, 46.

5. Language Measures

Two types of language measures are included: (1) samples of children's oral and written language obtained under controlled conditions, and (2) tests devised to measure performance on specific aspects of language.

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[9] Constructed by Sylvia Rosen and Mildred C. Templin.

[10] Constructed by Ronald J. Johnson and Mildred C. Templin.

5.1 Recording. Sessions 3 and 9. See Appendix C.

5.2 Berko Morphology Test. Sessions 3, 5 and 7. This research instrument was devised by Berko (5) to determine a child's ability to apply different types of morphological rules to nonsense words. The instrument is made up of 33 items in which the rules for formation of plurals, possessives, tenses, etc. can be applied. For example, the rule that the plural of a stem ending in /s, z, ʒ, tʃ, dʒ/ is formed by the addition of a syllable, /əz/, is tested in the formation of the plurals in the nonsense words tass, niz, kazh, gutch and loodge. Pictures represent the nonsense words. For example, in the formation of the plural of gutch, the examiner, pointed first to the upper figure pictured on a 5 x 8½ card and said, "Here is a gutch." Then indicating two similar figures in the lower part of the card, he said, "Now here is another one. There are two of them. There are two---." The child's response was recorded using the International Phonetic Alphabet.

Some arbitrary scoring decisions were made to minimize the effect of any misarticulations upon a child's morphology score. For example, the plural of a word ending in /p, t, k, f, θ/ is formed by the addition of /s/ to the stem. Credit was given if the /s/ or any unvoiced sound, any fricative sound, or any sound habitually substituted for the /s/ by a given child was added.

While the nature of the incorrect response has been classified, in the analyses the quantitative score used is the number of correct responses, maximum 33.

5.3 Berko Compound Word Test. Sessions 3 and 5. This research instrument was devised by Berko (5) to determine whether children were aware of morphemes making up compound words. The subject was to tell why the things designated by the following compound words were so named: afternoon, airplane, birthday, breakfast, blackboard, fireplace, football, handkerchief, holiday, merry-go-round, newspaper, sunshine, Thanksgiving, Friday. The subjects responses were transcribed verbatim and classified into nine categories. The quantitative score used is the sum of responses in three of the categories that indicated the subject had some understanding of the meaning of the word: (1) etymological explanation that takes into account both parts of the word, (2) reference to object's salient function or feature, e.g., "You write on it." and (3) salient feature or function coincides with part of name, e.g., "Because it is black." The maximum score is 14.

5.4 Berko Word Usage Test. Session 6. This research instrument was devised by Brown and Berko (8) to determine whether the attributed meaning of a nonsense word used in a sentence was expressed by the subject in the same part of speech as the nonsense word. The test consists of 12 sentences in which the nonsense word is used twice as a count noun, a mass noun, a transitive verb, an intransitive verb, an adjective and an adverb. The order of presentation of pictures of a person or animal doing nothing and twelve nonsense words used in the presentation of the items was systematically predetermined. Illustrations of the attempt to elicit a noun and an adjective follow. In the former the examiner said: "Do you know what a wug is? This is a picture of a (little boy) thinking about a wug. What do you think that could be?' For the latter the examiner said "....This is a picture of a (little girl) thinking about something wuggy...." The score for the test is the number of sentence-items in which the nonsense word was translated into a conventional English word of the same part of speech. Maximum score is 12.

5.5 Sentence Completion Test.[11] Session 8. Ten open-end stimulus phrases are used to elicit written sentence completions. The stimulus phrases were constructed to sample attitudes toward a variety of language experiences and were cast so that different language structures would be used in completing them, e.g., "When I have to read ________." "Spelling is _________." The stimulus phrases are presented in Appendix B.

Scores used are: (1) total number of words used in the sentence completions; (2) number of different words used; (3) number of hard words used. Hard words are defined as those not contained in the Dale List of 769 East Words (12).

5.6 Jenkins-Palermo Word Association Test. Sessions 6 and 10. The test consists of the 100 words used by Palermo and Jenkins with subjects from first grade through college. The examiner read the test words to each child individually and wrote his responses on the test blank. The commonality score is the sum of the most frequent responses of Palermo and Jenkins' normative subjects of the same age and grade used by each child (28, 39, 40). Scores at Session 6 were based on normative data for second grade boys and girls; those at Session 10 on that for fourth grade boys and girls. Maximum commonality score is 100.

5.7 Written Composition. Session 11. See Appendix C.

6. Auditory Stimulus Measures

Tests included in this section represent a variety of measures in which auditory stimuli are used. Many of the tests measure behavior associated with reading readiness and early reading.

6.1 Spencer Identification of Initial Sounds. Sessions 3 and 5. The test devised by Spencer (55) to assess a child's ability to identify pictures beginning with selected single sounds presented aurally was increased from seven to ten items. After a child had named the pictures of fifteen objects the examiner told him to listen carefully and then to find a picture of something that began with the single sound that the examiner uttered. The 15 pictures, with the ten test items marked with an asterisk follow:

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[11] Constructed by Susan B. Prindle and Ronald J. Johnson.

meat
baby
*hammer
*sock
*wagon
*lamp
*table
bike
*candy
iron
mittens
*apple
*feather
*chicken
*doll

In Session 3 the test was discontinued if the child failed to pass the first three items after several preliminary illustrations. In Session 5 the entire test was always given. The score on the test is the number of correct responses, maximum 10.

6.2 Spencer Rhyming Words Test. Sessions 3 and 5. The test consists of ten items, five in which the rhyming word was identified from among eight pictures, and five in which the child is asked to give a word that rhymes with a stimulus word produced by the examiner. The test is similar to that developed by Spencer (55) except that the number of items is increased from eight to ten. The child was asked to find among pictures of cup, cat, bus, bed, horn, tent, coat, bread those that rhymed with sat, boat, corn, us, sent. Two demonstration items were provided. The five words for which the child was asked to find rhyming words without pictures are: hear, tree, fair, nose, fun. Maximum scores are: picture items, 5, nonpicture items, 5, total test, 10.

6.3 Spencer Synthesis of Words. Sessions 3 and 5. The test consists of 16 items. Eight items measure the child's ability to synthesize words from two or three syllables, e.g., from ba - by or um - brel - la. Eight items measure ability to synthesize words from two or three sounds: e.g. ʃ - u or f - ɪ - ʃ. The test is similar to that described by Spencer (55) except that it has been lengthened. The maximum scores are: synthesis of syllables, 8; synthesis of sounds, 8; total synthesis score, 16.

6.4 Monroe Sound Discrimination. Session 4. This is Auditory I Test in the Monroe Reading Aptitude Tests (34). It consists of a series of nine line drawings of a boat, cup, hen, hand, basket, rat, flower, hammer, streetcar. For each the child is asked to identify the correct pronunciation of the pictured object from among three English words differing in only one phoneme said by the examiner. Maximum score is 12.

6.5 Monroe Synthesis of Words Test. Session 4. This is Auditory II Test in the Monroe Reading Aptitude Tests (34) in which the child is to identify each of the following 12 pictures from the separate sounds of the word uttered by the examiner: shoe, cat, mother, house, track, pan, lap, peas, engine, puddle, gate, bud. The maximum score is 12.

6.6 Templin Sound Discrimination Test. Sessions 3 and 5. The test consists of 50 pairs of syllables that have been found most discriminating and used in earlier work by Templin (63). Each pair, either an identical pair (e.g. le - le) or a minimal pair (e.g. eʃ - etʃ) was uttered by the examiner and judged to be "Same" or "Different" by the child. The maximum score is 50.

6.7 Harrison-Stroud Matching Sounds I. Session 4. This is Test 4 from the Harrison-Stroud Reading Readiness Profiles (21). For each of 16 items three pictures are presented within a boxed area, and the child is to draw a line from the stimulus picture to the one other picture that begins with the same sound. The stimulus pictures are: radio, dog, leaf, soldier, gate, finger, mitten, comb, book, rubbers, nut, can, pie, table, horse, wood. One point is given for each correct response, with a maximum score of 16.

6.8 Harrison-Stroud Matching Sounds II. Session 4. This is Test 5 from the Harrison-Stroud Reading Readiness Profiles (21) in which the child is to identify an initial sound from within a category for 18 items. For example, pictures of ring, rabbit, and calf are presented and the child is told the following story and then asked to identify the pet that ran away: "Roy had two pets on his grandfather's farm. One pet ran away. The pet that ran away begins like Roy's name." Maximum score is 18.

6.9 Auditory Memory Test.[12] Session 7. Separate scores are obtained for each of the four parts presented in Appendix B. Part 1, Digit Repetition, contains seven items in which two to nine digits are to be repeated. Maximum score, 9. Part 2, Word Repetition, consists of six items in which three to six unrelated words are to be repeated in the appropriate order. Maximum score, 6. Part 3, Story Comprehension, in which "The School Concert" (57) was read aloud and questions about the story asked the child. Maximum score, 6. Part 4, Sentence Repetition, in which nine sentences that systematically increase from five to 21 words in length are to be repeated after the examiner. Score is the number of words in the longest sentence accurately repeated. Maximum score is 21.

6.10 Spencer Nonsense Recall. Session 3 and 5. Test was developed by Spencer (55) to determine a child's ability to reproduce correctly sounds and syllables presented to him with mock conversational inflection. It consists of 12 items in which the number of syllables ranges from two (e.g. bə - kʌ) to five (e.g. bɑ - ker - no - pe - di). Two scores were obtained: (1) the number of items in which both the number of syllables and the articulation of the sounds in the entire phrase were correct; and (2) the number of items in which the correct number of syllables was repeated with no consideration of the articulation of the sounds. Both maximum scores are 12.

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[12] Constructed by Nancy Cowan and Mildred C. Templin.

7. Visual Stimulus Measures

All tests are either part of or an entire previously published test. Most of the measures are associated with reading readiness or with early reading skill.

7.1 Metropolitan Readiness Test. Session 4. The Metropolitan Readiness Test, Form R (22) was designed for use at the end of kindergarten or at the beginning of the first grade. Six separate subtests make up the test. They, and the maximum score for each, are: Word Meaning, 19; Sentences, 14; Information, 14; Matching, 19; Numbers, 24; Copying, 10; and Total Score, 100.

7.2 Murphy-Durrell Matching Letters. Session 4. From the Murphy-Durrell Reading Readiness Tests (37), Items 1-26 of Test 2 Visual were used. The child matches a single letter with one of five letters in a row in his test booklet. Published directions were followed in the administration except that they were adapted for use with individual children, e.g. the stimulus letter was presented the child on a 3 x 5 card. The maximum score is 26.

7.3 Murphy-Durrell Matching Words. Session 4. This test is Items 27-52 of Test 2 Visual of the Murphy-Durrell Reading Readiness Tests (37). The child matches a single stimulus word with one of five words presented in his test booklet. Except that the stimulus words were presented on a 3 x 5 card published directions were used with the individual children. The maximum score is 26.

7.4 Clymer Picture Squares. Session 4. This test developed for research use by Dr. Theodore Clymer (11) provides a series of nine pictures massed into squares containing three rows of three pictures each. The task for the child is to draw a line between the two identical pictures in each of 18 squares within the two minutes allotted. In four practice items the child was given as much help as needed to understand the task. Three scores were obtained: (1) the number of correct items, (2) the number of items attempted, and (3) the ratio between the number correct to the number attempted times 100. The maximum scores are 18, 18 and 100, respectively.

7.5 Gates Recognition of Digits, Capital and Lower Case Letters. Session 4. This test from the Gates Primary Reading Test (15) was designed to determine whether a child could orally identify the digits through 9, and the 26 lower case and capital letters. The maximum for the three scores obtained is: Digits 10; Lower Case Letters 26; and Upper Case Letters 26.

8. Personality Measures

The category, Personality Measures, covers a variety of types of measures that are loosely related to the subject's personality, adjustment and perceived environment. The instruments, for the most part, are clinical and sometimes exploratory in nature. Results on many are not included in the analyses because they give categorical scores, or no scores are yet available.

8.1 Bene-Anthony Family Relations Test. Session 3. This clinical instrument (4) provides an objective technique to explore the child's feeling towards the various members of his family and his estimate of their reciprocal regard for him. The test material consists of 21 figures representing people of both sexes and various ages, each attached to the front of a box with a slit in the lid. From these the child selects figures to represent the actual members of his family. The figures selected plus a figure representing "Nobody" are considered in his responses to 40 questions or messages printed on small cards. These messages sample: (1) positive feelings coming from the child, (2) positive feelings experienced by the child as coming from others, (3) negative feelings coming from the child, (4) negative feelings experienced by the child as coming from others, and (5) feelings of dependency on others.

In the administration of the test, the cards are first shuffled and then the message on each card is read to the child who associates it with a person or persons represented by the selected figures. An example of a message in the area of positive feeling coming from the child is: "(Name of child being tested) thinks you are nice. Who is nice?" An example of negative feelings experienced by the child as coming from others is: "You say (Name of child) is naughty. Who says (Name of child) is naughty?"

In a clinical evaluation, the distribution of the various types of messages is considered. A quantitative score was devised to indicate the extent of the positive attitude of the child to his perceived family situation. It does not include dependency items, but is the sum of all positive messages associated with any family member and all negative messages associated with "Nobody." The maximum scores is 32.

8.2 Bender-Gestalt Test. Session 10. The Bender-Gestalt Test (3) was scored using the Koppitz (30) system to obtain both total developmental and emotional scores. The better score is the lower score for the emotional scale.

8.3 Adjective Check List. Before Session 10. See Appendix C.

8.4 Thematic Apperception Test. Session 10. See Appendix C.

8.5 Teacher's Rating.[13] Session 8. The teacher separately rated the attention span and listening ability of each child on a four-point scale indicating their possible handicap for school experience. Scores as followed were assigned on each: no handicap, 0; a slight handicap, 1; a moderate handicap, 2; a severe handicap, 3.

8.6 Subject Preference Questionnaire. Session 8. See Appendix C.

8.7 Process of Drawing-a-Man. Session 9. See Appendix C.

8.8 Parents' Questionnaire. Session 7. See Appendix C.

9. Intelligence Measures

The following standard tests of intelligence were given:

9.1 Wechsler Intelligence Scale for Children (WISC). Before Session 10. IQ's are based on the Verbal, Performance and Full Scales of the WISC (70).

9.2 Ammons Full-Range Vocabulary Test. Session 3. IQ-Equivalents are used (1).

9.3 California Test of Mental Maturity. Session 3. See Appendix C.

9.4 Goodenough-Harris Draw-a-Man Test. Sessions 5 and 9. The Harris revision of scoring was used (20).

9.5 Porteus Maze Test. Session 11. Only the quantitative scores, IQ and Test Age, are used, although qualitative scoring was done (41, 42).

10. Motor Measures

Tests included under Motor Measures have a substantial motor component although they are not tests of specific motor abilities.

10.1 Stambak Test of Rhythm. Session 11. Two of the three separate tasks in the Stambak Test of Rhythm (74) are included in the analyses. (1) The spontaneous tapping rate task was given as the first and last item. The subject was asked to tap the table with a pencil over and over again until told to stop. The score was the time in tenths of seconds taken to tap 21 times, with the timing begun after five or six taps. (2) The reproduction of rhythmic patterns task consists of the reproduction by the child of the pattern tapped out of his sight by the examiner. The task is made up of 21 items, but is terminated after four consecutive failures except that 12 patterns are always presented. Scores are: the number of correct patterns correctly reproduced among the first 12 items, maximum score 12; and the number of patterns correctly produced in the entire test, maximum score 21.

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[13] Constructed by Nancy Cowan and Mildred C. Templin.

10.2 Evaluation of Handwriting. Session 8. The subject's handwriting on Test 5.5, Sentence Completion, was evaluated on a five-point scale[14] devised especially for the project.

10.3 Adequacy of Speech Mechanism. Session 3. See Appendix C.

Administration of the Tests

All children were tested individually except in those few instances that were noted in the description of the measures. Since the testing was carried on in a large number of schools, the procedures used took into account a wide variation of physical testing conditions. Testing was carried on primarily in October and November and April and May of each year. Tests were administered by persons initially selected because of their qualifications and then given specific training preceding each testing period. Articulation tests were administered by speech clinicians, for the most part at the Master's level with some experience in the public schools. Other measures were administered by the speech clinicians or persons with backgrounds in psychology or education. In addition to the testing by the project examiners, the Minneapolis Public School speech clinicians administered Tests 1.6, 1.7, 6.6 and 6.10 at Session 5, and eight psychometrists administered the WISC during the summer between Session 9 and 10. The examiners were not aware of the bases for selection of samples for study.

Before each testing period, training sessions were conducted on the particular tests to ensure maximum agreement on procedures among the examiners. Administration of the tests was demonstrated; examiners were observed in their administration of new measures to practice subjects. When evaluative judgments were necessary, criteria for them were precisely stated. Reliability among the examiners was established before any tests were administered to longitudinal study subjects.

The psychometrists who administered the WISC were employed as school psychologists during the school year or were graduate students at the University of Minnesota with sufficient training and experience in the use of the WISC to be considered qualified testers. A training session was conducted by a clinical psychologist to ensure uniformity in administration and in scoring procedures used. The clinical psychologist rescored all the WISC's, and these scores have been used in the analyses reported.

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[14] Constructed by Karen Lamb.

Throughout all the testing not only the correctness or the incorrectness of a response, but the particular incorrect response was noted. For example, in vocabulary recognition tests, 3.2 and 3.3, if the word was incorrectly read the actual response was recorded. Although in the analyses presented, only quantitative scores based upon the correctness and incorrectness of the responses are used, data are available so that characteristics of performance of individual subjects can be considered.

Method of Analysis

Using the quantitative scores indicated in the description of the measures, analyses were made to: (1) trace change in mean articulation scores for each sample from session to session; (2) compare mean performance of the several samples on non-articulation measures obtained throughout the course of the study; and (3) determine, within each sample, the correlation between articulation and non-articulation test scores. In all analyses the percentile, shift and phoneme samples, boys and girls, were considered separately. Since samples were drawn for study according to certain aspects of articulation performance in kindergarten, they could not be combined to represent the total population of subjects tested in Session 1.

The statistical techniques used were simple. For the first two analyses means and standard deviations were inspected, and _t_ tests used selectively to determine the significance of differences obtained. The selective use of the _t_ test is illustrated in comparing articulation scores of the 7th and the 98th percentile samples. It was first applied where the actual difference in scores was smallest (in most instances at Session 11). If this smallest difference was found to be statistically significant at the .01 level of confidence all greater differences on the same score were considered significant at that level, except when large standard deviations indicated that the significance of the difference be calculated. If the smallest difference was not significant or significant at the .05 level of confidence, the _t_ test was applied successively to the next greater differences (usually to the preceding test session) until the pattern of significance had been ascertained. A similar selective determination of the significance of differences was applied to comparisons of non-articulation scores obtained by the percentile samples, and by the phoneme samples, boys and girls.

For the third type of analysis product-moment correlations were computed between criterion scores and quantitative test scores for each sample at each session using a computer program for missing data correlations. The criteria measures selected were: 1.5, Long Articulation Test, cluster scores, Session 6 and Session 11;

4.2, Metropolitan Spelling Test, Session 8; and 3.1, Gates Reading Survey, Session 11. (Means and standard deviations of these scores are presented in Tables A-9 and A-17.) The spelling and reading criteria scores were based on standardized tests administered as late as possible in the series of test sessions. The criterion reading test was administered at Session 11. The criterion spelling test was selected from an earlier session, because the spelling test administered at Session 11 was constructed specifically for the study and was not a standardized measure. Articulation criterion scores were obtained when subjects, at-grade would have been beginning second or completing fourth grade. The Session 6 criterion was selected because public school speech therapy practice and cross-sectional studies suggest this grade level as a period when mature articulation should be apparent, and because it was also the terminal testing session supported under USOE Project # 818. The cluster score was selected as the criterion because it was based on a larger number of items than any of the other articulation scores; it does not include any evaluation that is used in determining another articulation score; and means for all samples are below the maximum score at Session 11.

Data on individual subjects were, on the whole, nearly complete. Nevertheless, it is almost inevitable that some tests are missed or invalid when a large number of tests are given subjects over a five-and-a-half year span. Of the nearly 60,000 tests administered 241 missing or invalid tests were scattered among the different sessions, samples and subjects. All missing scores were estimated and used in the calculations. The estimated score based on a test that was administered at only one session was the calculated mean of that test score for the particular sample and session. If a subject was missing a score based on a test that was administered in successive sessions, the estimated score was the best judgment based upon the subject's own scores at the immediately preceding and following sessions, and upon the means of his sample at these sessions and the one in which the missing score occurred.

It is probable that the 50 subjects lost from the sample did not substantially change the results obtained. Several articulation scores of each of these subjects were compared with the distributions of the same scores for the samples from which they had been dropped at Session 3 and at the last session for which data were available for the dropped subjects. Because these subjects were scattered throughout the samples and sessions, only general comparisons were possible. However, all scores fell within the range of the distributions of the particular samples and sessions at which comparisons were made. A very few of the dropped subjects in the 7th percentile sample had scores that tended toward the upper extreme of the distribution for their sample, but they still were clearly more like their own sample than the 15th percentile sample.

RESULTS

Results of the analyses of articulation development and of the relations between scores on various measures and articulation, reading and spelling are presented for the percentile, shift and phoneme samples, boys and girls.

Articulation Development

Means and standard deviations for all of the scores that are used in the analyses of articulation are presented in Appendix A for the percentile, shift and phoneme samples for boys and girls, and for each session in which the scores were obtained.

Repeated Articulation Measures

The scores of repeated measures used to trace development of articulation are listed below.

1.2 Prekindergarten Imitation Articulation Test: Session 1 through 11

total score (Table A-4)
initial consonant score (Table A-5)
final consonant score (Table A-6)
total consonant score (Table A-7)

1.4 Kindergarten Imitation Articulation Test: Sessions 3 through 11

total score (Table A-8)

1.5 Long Articulation Test: Sessions 3 through 11

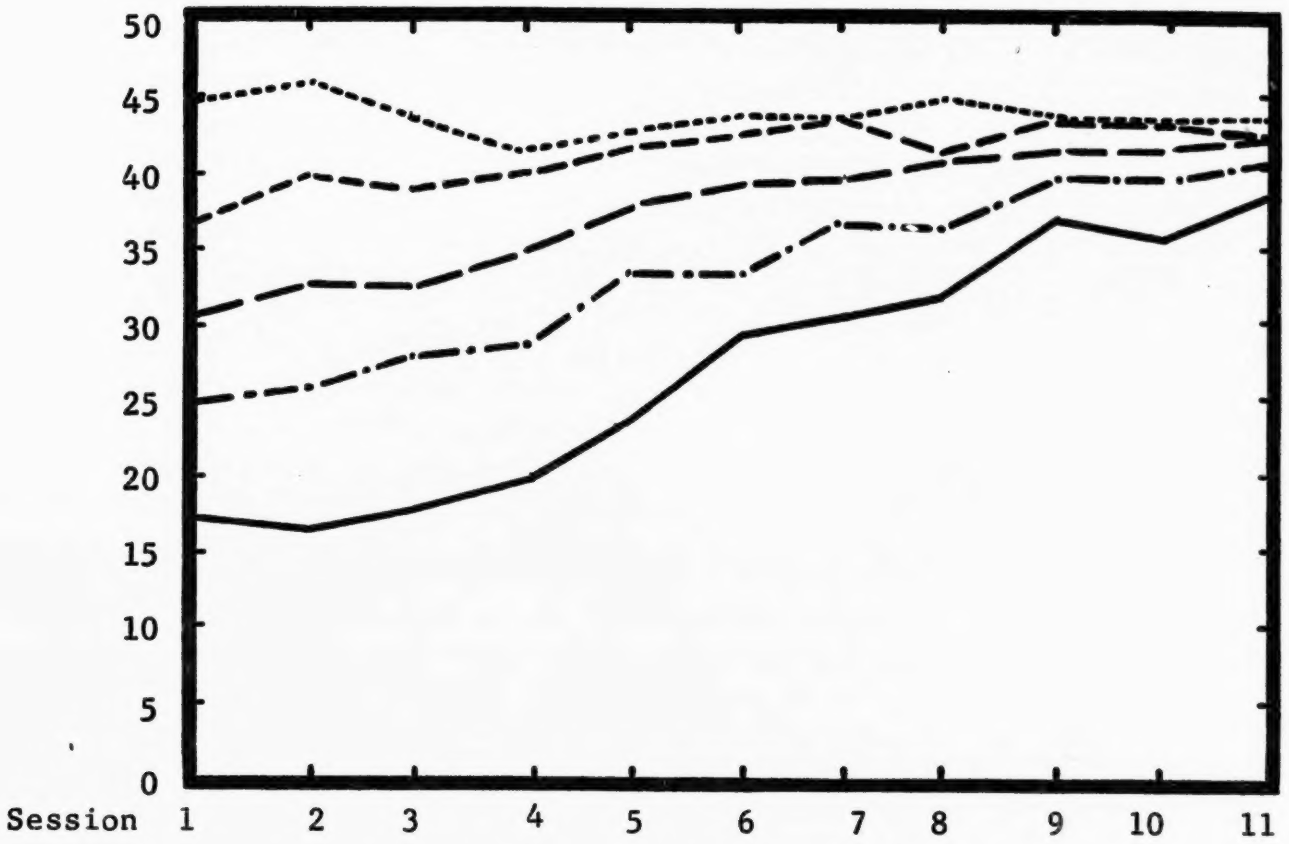
cluster score (Table A-9)

1.6 Spencer Nonsense Word Articulation Test: Sessions 3, 5 through 11

initial consonant score (Table A-10)
final consonant score (Table A-11)
total consonant score (Table A-12)

Examination of Tables A-4 through A-12 indicates that the patterns of change in mean scores from test session to test session differ among the samples, but are quite consistent for all articulation test scores and for each sex. Data on Test 1.2, total score, and Test 1.5, cluster score, are presented graphically for both sexes in Figures 2 through 5 as illustrative of changes in all test scores over the testing period.

BOYS



GIRLS

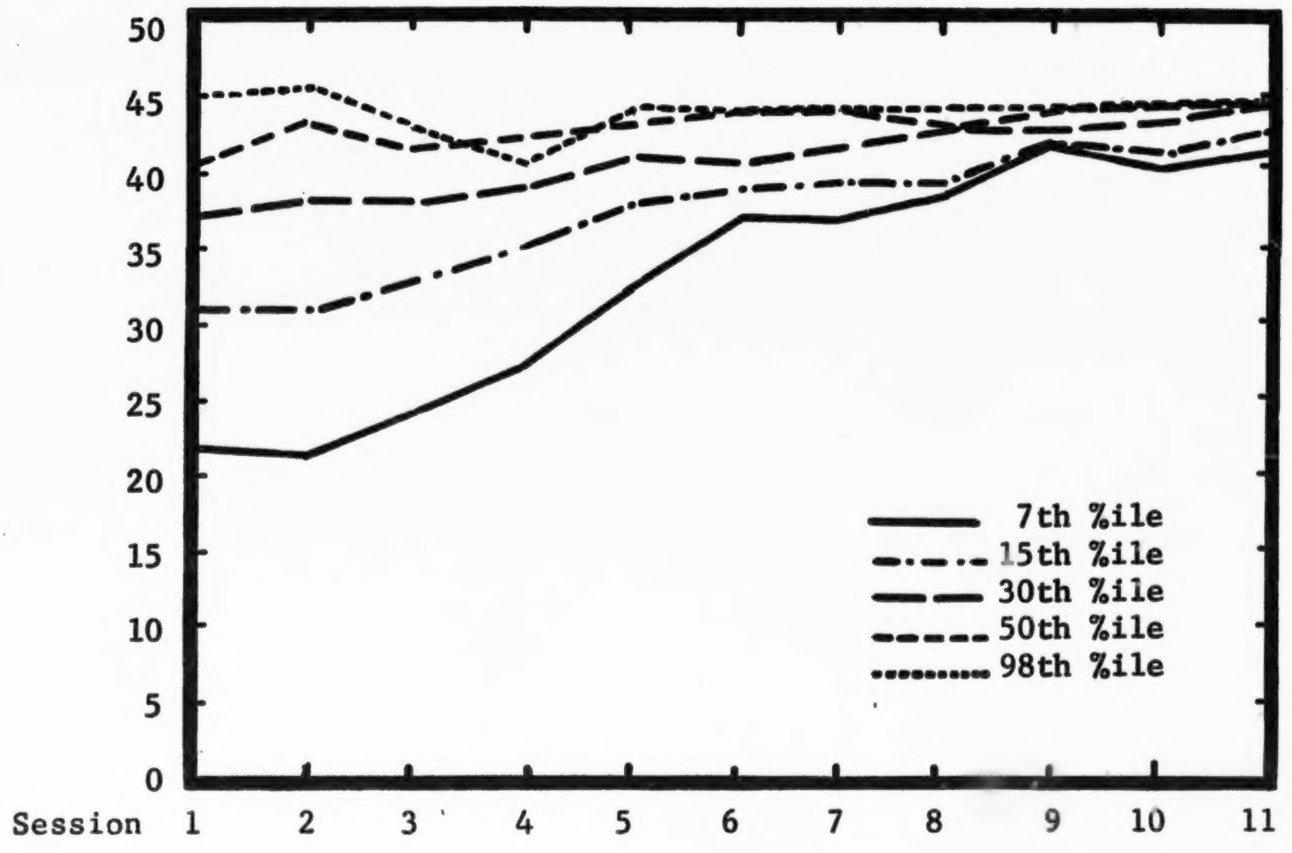


Figure 2. Mean Scores on Prekindergarten Imitation Test, Total Score, for All Sessions by Percentile Samples and Sex.

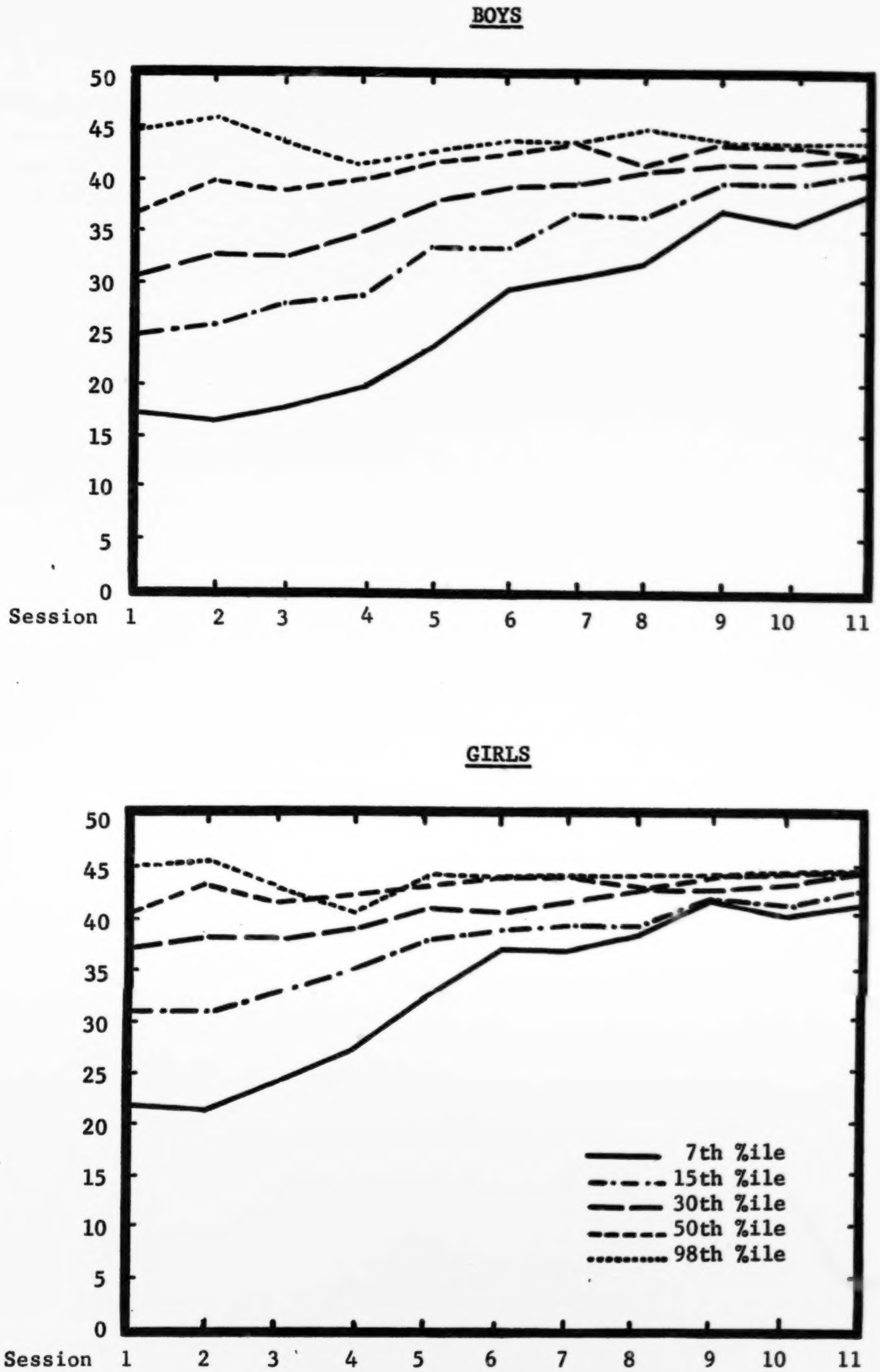
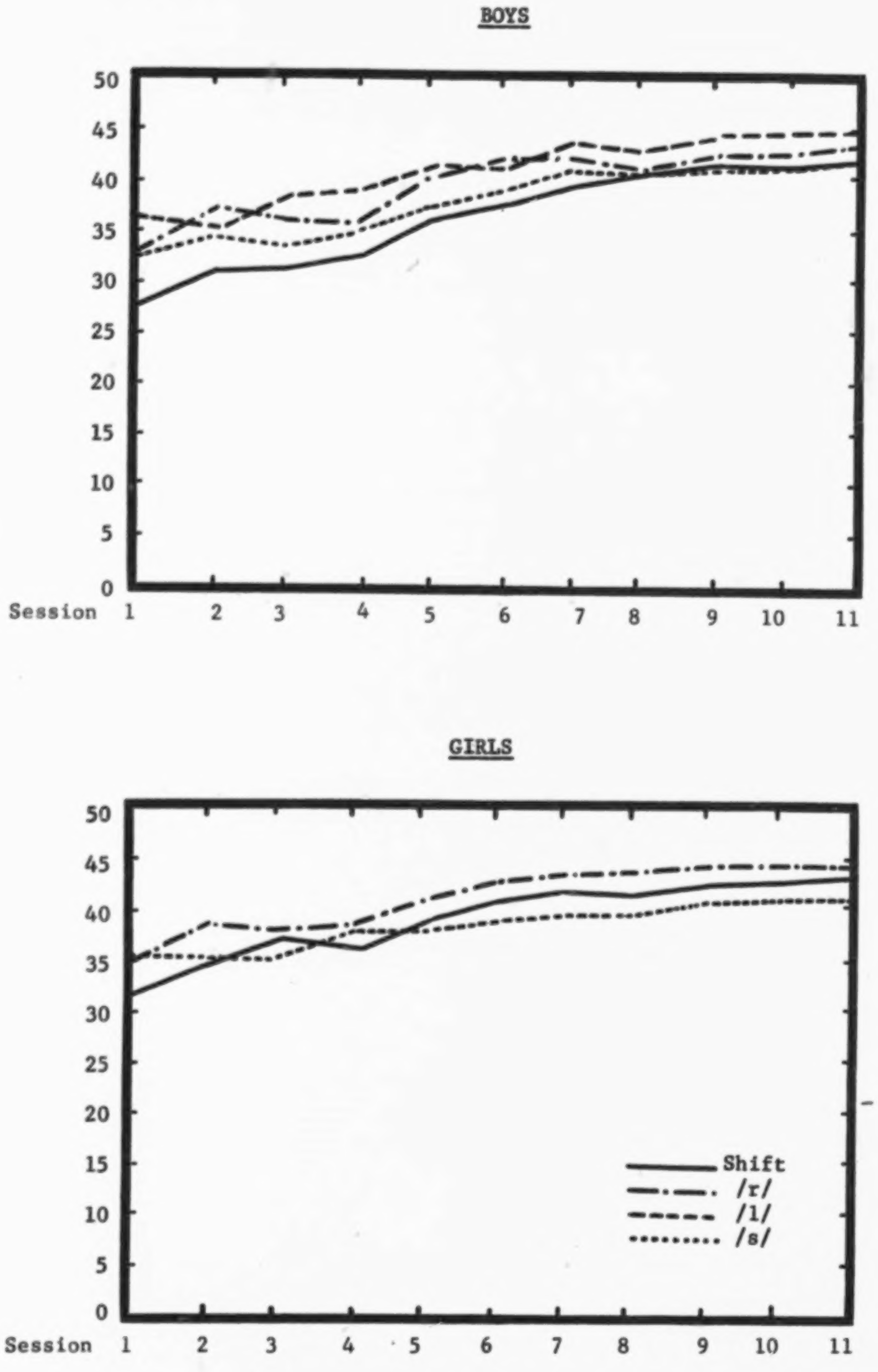


Figure 2. Mean Scores on Prekindergarten Imitation Test, Total Score, for All Sessions by Percentile Samples and Sex.


BOYS

GIRLS

Figure 3. Mean Scores on Prekindergarten Imitation Test, Total Score, for All Sessions by Shift and Phoneme Samples and Sex.

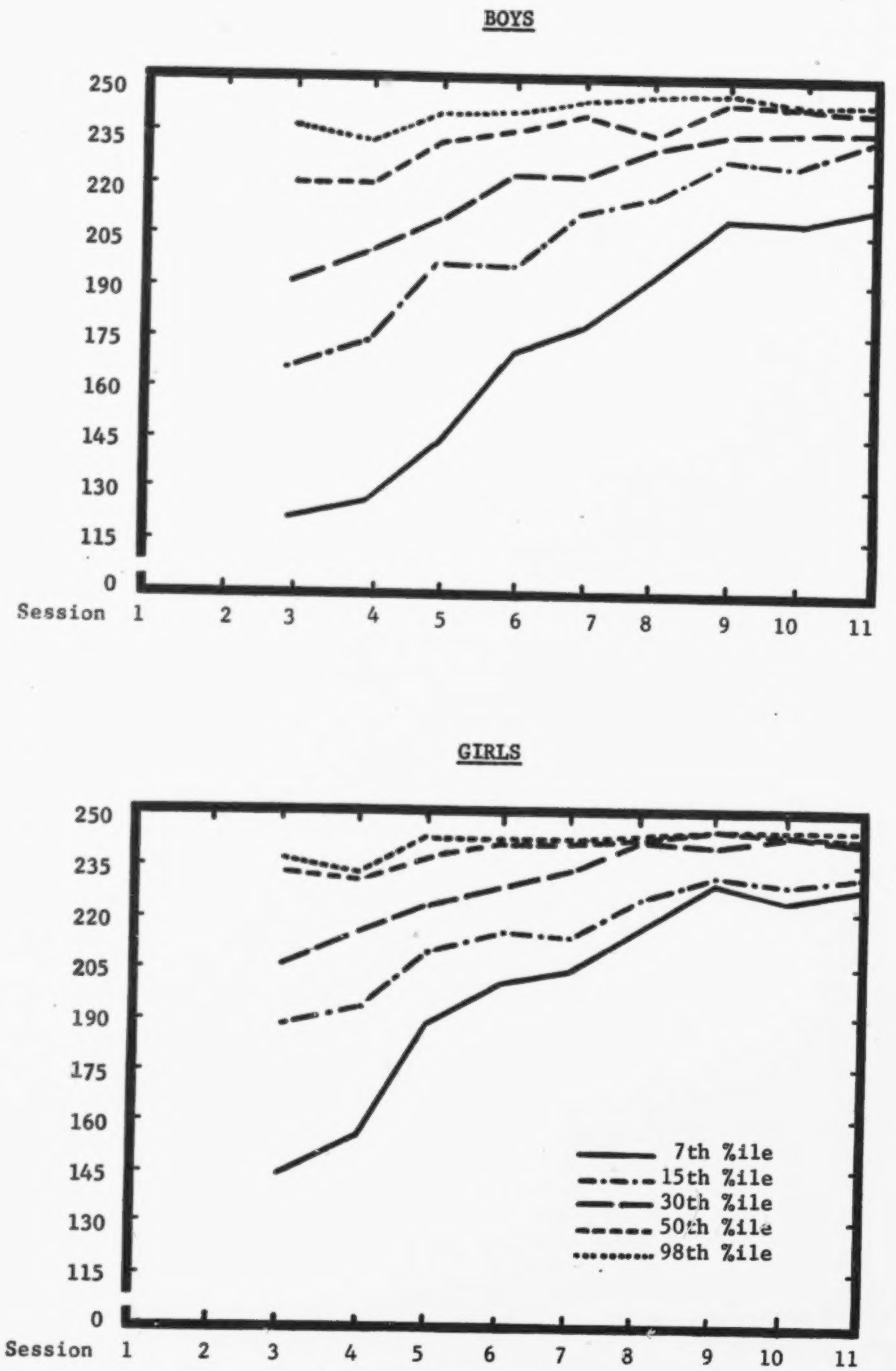


Figure 4. Mean Scores on Long Articulation, Cluster Scores, Sessions 3 through 11, by Percentile Samples and Sex.

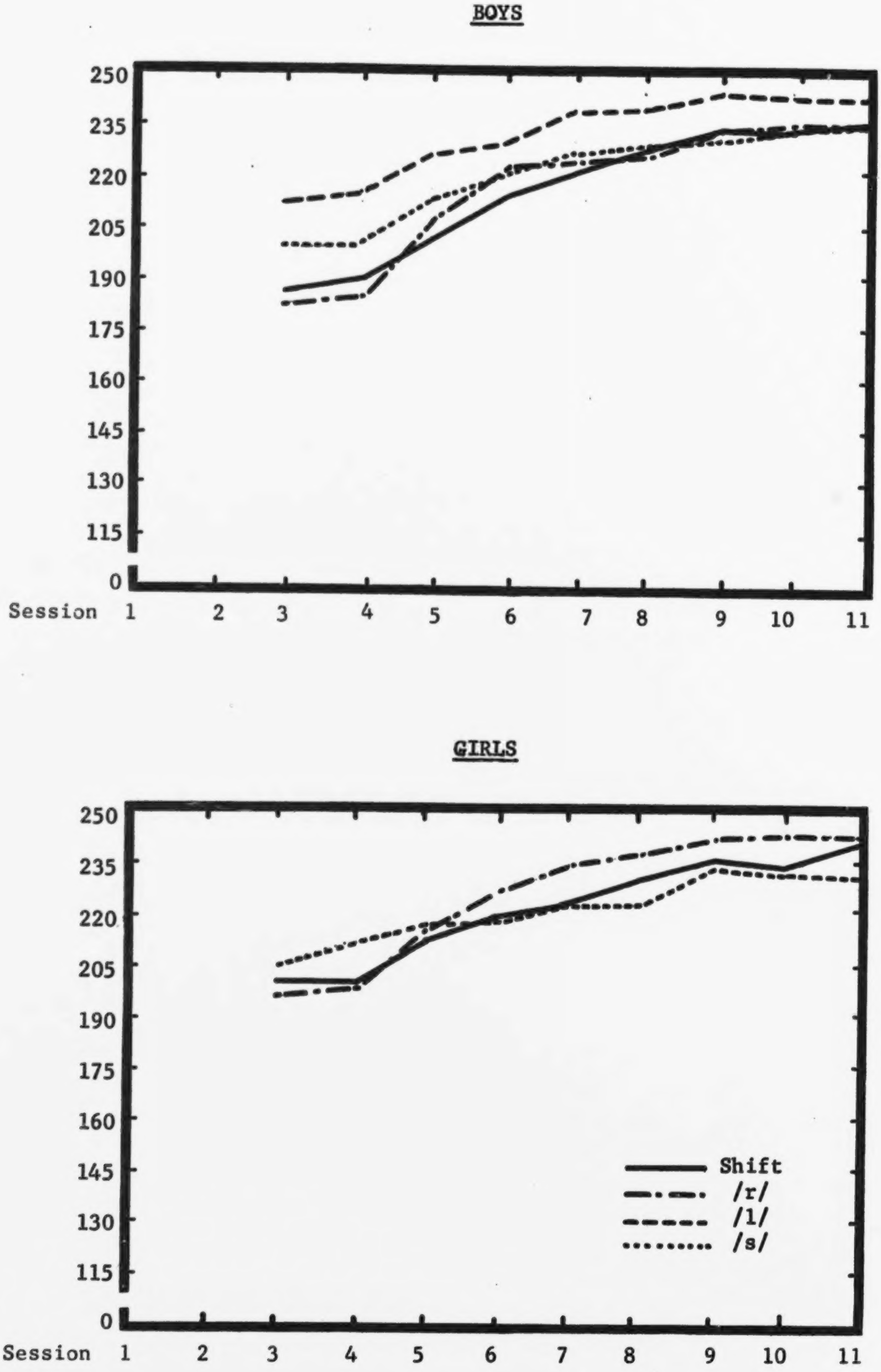


Figure 5. Mean Scores on Long Articulation, Cluster Scores, Sessions 3 through 11 by Shift and Phoneme Samples and Sex.

Percentile Samples. For each repeated articulation measure the percentage of possible score attained by the percentile shift and phoneme samples at Session 11 is presented in Table 2.

Table 2. Percentage of Possible Articulation Scores at Session 11 for Percentile, Shift and Phoneme Samples by Sex.

BOYS	Percentile Samples				
Test and Score	7	15	30	50	98
1.2 Total	82.6	89.9	94.2	95.1	96.6
1.2 Initial Consonant	88.0	92.3	96.5	96.2	98.8
1.2 Final Consonant	88.5	92.3	94.0	97.1	96.2
1.2 Total Consonant	88.4	92.3	94.9	96.7	97.2
1.4 Total	85.4	91.6	93.7	95.8	97.2
1.5 Cluster	85.6	93.8	94.9	97.0	98.5
1.6 Initial Consonant	91.3	94.8	97.2	98.2	99.3
1.6 Final Consonant	85.0	92.0	94.9	95.0	98.0
1.6 Total Consonant	88.3	93.4	96.0	96.1	98.7
GIRLS					
1.2 Total	89.0	91.6	96.2	97.0	97.7
1.2 Initial Consonant	95.2	93.5	97.5	98.8	96.5
1.2 Final Consonant	91.4	93.7	96.4	97.2	95.8
1.2 Total Consonant	92.9	94.0	96.8	97.9	95.8
1.4 Total	90.8	92.9	96.9	97.5	98.0
1.5 Cluster	91.5	93.0	96.7	98.1	98.7
1.6 Initial Consonant	96.2	96.9	98.6	99.2	99.5
1.6 Final Consonant	92.7	94.4	95.2	97.1	98.0
1.6 Total Consonant	94.5	95.7	97.0	98.2	98.8

	Shift Sample	Phoneme Samples		
BOYS		/r/	/l/	/s/
1.2 Total	90.7	95.9	97.7	91.5
1.2 Initial Consonant	95.1	98.2	98.6	93.6
1.2 Final Consonant	92.2	96.2	97.8	93.8
1.2 Total Consonant	93.3	96.9	98.1	93.7
1.4 Total	92.1	95.9	98.1	92.9
1.5 Cluster	94.1	95.0	98.5	94.4
1.6 Initial Consonant	97.2	98.3	98.2	94.3
1.6 Final Consonant	92.0	95.1	96.9	91.5
1.6 Total Consonant	90.7	96.7	97.6	91.5
GIRLS				
1.2 Total	94.7	97.6	---	90.7
1.2 Initial Consonant	98.3	98.4	---	91.7
1.2 Final Consonant	95.4	97.8	---	92.0
1.2 Total Consonant	96.5	98.0	---	91.9
1.4 Total	95.6	97.8	---	92.1
1.5 Cluster	96.0	97.8	---	93.0
1.6 Initial Consonant	98.0	99.1	---	95.5
1.6 Final Consonant	93.4	96.0	---	93.0
1.6 Total Consonant	95.8	97.6	---	94.3

From this table it is seen that at Session 11 the mean articulation scores attained by the 50th and 98th percentile samples, boys and girls, and for the 30th percentile sample, girls, are all above 95 per cent of the maximum. The percentage scores attained by the 7th percentile samples are the lowest for both sexes: essentially they are in the 80-90 percentage range for boys and in the lower 90 percentage range for girls. At Session 11 the 7th, 15th and 30th percentile samples, boys, attain successively higher percentage scores on all tests. The same holds for these percentile samples, girls, on all except Test 1.2, initial consonant score. On most tests the scores of the 15th percentile sample girls, and the 15th and 30th percentile samples, boys, are somewhat higher, but still below those of the upper percentile samples.

Throughout the testing period, the mean scores of the 7th percentile samples are lowest at each testing session. For boys, mean scores of the 7th percentile sample are significantly below those of the 98th percentile sample at the .01 level of confidence on all articulation tests at all sessions with one exception: Test 1.2, final consonant scores, Session 11, differ at the .05 level. For girls through Session 10 all differences between scores of the 7th and 98th percentile samples are significant at the .01 level except for Test 1.2, Session 10, final consonant score, which reaches the .05 level. At Session 11 for girls, however, differences are not significant for Test 1.2, total and initial consonant scores; at the .05 level for Test 1.2, final consonant score, and for Test 1.6, initial and final consonant scores; and at the .01 level for total scores on Tests 1.2, 1.4 and 1.6, and for Test 1.5 cluster score.

The relative positions of the percentile samples remain the same on all articulation test scores either from Session 2 through Session 11 or until about 95 per cent of the maximum score on any particular measure is attained (see Figures 2 through 5 for examples).

When the mean scores attained by the 7th percentile samples, both sexes, at Session 11 are compared with those attained throughout the testing sessions by the other percentile samples, the consistency and extent of the retardation in their articulation development are apparent. In Table 3 it is seen that the mean scores attained by the 7th percentile samples, both sexes, at Session 11 are attained by the 15th percentile samples from two to four sessions, or one to two years earlier; by the 30th percentile samples from five to six, or two-and-a-half to three years, earlier; by the 50th percentile samples either before the initial testing or from six to ten sessions (three to four years) earlier; and by the 98th percentile samples before the initial testing or about four-and-a-half to five-and-a-half years earlier on all articulation scores.

Table 3. Earliest Session at Which Mean Articulation Test Scores of Other Percentile, Shift and Phoneme Samples Approximate Those of the 7th Percentile Samples at Session 11, Boys and Girls.

BOYS	Percentile Samples				Shift Sample	Phoneme Samples		
Test and Score	15	30	50	98		/r/	/l/	/s/
1.2 Total	7	5	1	*	6	2	3	5
1.2 Initial Consonant	8	5	3	*	6	4	3	6
1.2 Final Consonant	8	6	2	*	7	2,5	1,5	6
1.2 Total Consonant	9	6	4	*	7	5	5	6
1.4 Total	7	5	@	@	6	5	3	5
1.5 Cluster	7	5	@	@	6	5	3	5
1.6 Initial Consonant	7	5	@	@	7	3	3	5
1.6 Final Consonant	7	5	@	@	5	@	@	@
1.6 Total Consonant	7	5	@	@	6	@	@	3
GIRLS								
1.2 Total	8	5	1	*	6	5	-	8
1.2 Initial Consonant	9	7	4	*	8	6	-	9
1.2 Final Consonant	8	6	2	*	8	5	-	9
1.2 Total Consonant	8	6	2	*	8	6	-	9
1.4 Total	8	5	@	@	6	4	-	8
1.5 Cluster	8	6	@	@	7	6	-	8
1.6 Initial Consonant	9	5	@	@	8	5	-	9
1.6 Final Consonant	9	6	@	@	9	5	-	9
1.6 Total Consonant	8	6	3	@	8	5	-	9

* Before initial testing, Session 1
@ Before initial testing, Session 3

Shift Sample. From Table 2 it is seen that in the shift samples the percentage articulation scores attained by the girls are consistently slightly higher than by the boys. At Session 11 mean scores on all tests are similar to those of the 15th to 30th percentile samples, both boys and girls. In no instance, however, do these scores differ significantly (at the .05 level of confidence) from the scores attained by the 50th percentile samples.

Over the entire testing period, development of the shift samples most resembles that of the lower percentile samples. Examination of Tables A-4 through A-12 and Figures 2 through 5 shows that, with few exceptions, mean scores of the shift samples, boys and girls, fall between the scores of the 15th and 30th percentile samples at each session for all tests.

Mean scores of the shift sample, boys, approximate those attained by the 7th percentile samples at Session 11 on the nine articulation test scores about three years earlier. Those for shift sample, girls, approximate the performance of the 7th percentile sample from two to five sessions or one-and-a-half to two-and-a-half years earlier. (See Table 3.) These differences are similar to those of the 15th and 30th percentile samples when they are compared with the status of the 7th percentile sample at Session 11.

Phoneme Samples. It should be recalled that it was possible to select /r/, /l/ and /s/ phoneme samples, boys, at Session 2, but that only /r/ and /s/ phoneme samples, girls, could be selected. This suggests that girls more rapidly develop adequate production of the phoneme /l/.

At Session 11 the mean articulation scores attained by the /r/ and /l/ phoneme samples, boys, and the /r/ phoneme sample, girls, are all above 95 per cent of the maximum possible, and thus, are similar to those attained by the 50th to 98th percentile samples. Scores for the /s/ phoneme samples, both sexes, range between 90 and 95 per cent of maximum score and approximate the mean scores obtained at this session by the lower percentile samples. Nevertheless, at Session 11, the mean scores attained by the several phoneme samples do not differ significantly on any test score for girls. For boys, only on Test 1.5, cluster score, does the /l/ phoneme sample exceed the /r/ and /s/ phoneme samples at the .05 level of confidence.

Over the entire testing period, the articulation scores of the /r/ and /s/ phoneme samples, girls, do not differ significantly. Among the three phoneme samples for boys, no test scores differ significantly except Test 1.5, cluster score. On this score the /l/ phoneme sample, boys, consistently receives a higher score than the /r/ or /s/ phoneme samples at all test sessions. Differences between the /l/ and /r/ and between the /l/ and /s/ phoneme samples reach the .05 or .01 level of confidence at all sessions except Session 6. Although the articulation scores for the /r/ phoneme samples are consistently higher than those of the /s/ phoneme sample, the differences are significant only at Sessions 3 and 4.

Examination of Tables A-4 through A-12, and Figures 2 through 5 suggests that the rate of development of good articulation is slightly more accelerated for the /l/ and /r/ than for the /s/ phoneme samples. For boys, articulation test scores for all three phoneme samples tend, on the average, to resemble those of the 30th to 50th percentile sample in the early testing sessions. Scores of the 50th and 98th percentile samples are approximated by the /l/ phoneme sample at about Session 7, and by the /r/ phoneme sample at Session 11. In the later testing sessions scores of the /s/ phoneme sample are most similar to those of the 15th to 30th percentile samples. For girls, scores for both /r/ and /s/ phoneme samples are most similar to those of the 15th to 30th percentile samples at the initial testing. At the later sessions the scores of the /r/ phoneme sample approximate those of the 50th and 98th percentile samples, and those of the /s/ phoneme sample, approximate those of the 7th to 15th percentile samples on most tests.

Scores of the 7th percentile sample at Session 11 are approximated by the phoneme samples as follows: for boys the /l/ phoneme sample achieves this level about eight sessions or four years earlier, the /r/ phoneme sample between seven and eight sessions or about three-and-a-half years earlier, and the /s/ phoneme sample six sessions or three years earlier. For girls, the /r/ phoneme sample achieves the level about six sessions or three years earlier, the /s/ phoneme sample about two-and-a-half sessions or a little over a year earlier. (See Table 3.)

Other Measures

Two infrequently administered measures of articulation (Tests 1.7 and 1.8) and repeated ratings on intelligibility of speech (Test 2.1) are considered.

1.7 Duplicated Repetition: Sessions 3 and 5.

In Table A-14 are presented for all samples, both sexes, for each administration of the Duplicated Repetition Test the mean number of repetitions of /r/, /l/ and /s/ stimulus words, and all stimulus words combined.

Percentile samples. The number of repetitions of separate phoneme stimulus words, and the total of all stimulus words decreased systematically for each percentile sample, both sexes at Sessions 3 and 5 from the 7th, to the 15th, to the 30th, to the 50th, to the 98th with only one inversion.

The percentage of possible repetitions required by the 7th percentile samples, at both sessions are high, particularly for boys:

	Session 3			Session 5		
	/r/	/l/	/s/	/r/	/l/	/s/
7th percentile boys	89	60	70	81	47	60
7th percentile girls	86	44	60	63	33	36

For the 50th and 98th percentile samples, boys and girls, less than 25 per cent of the possible repetitions of single phoneme and all stimulus words were needed at Sessions 3 and 5. The three lower percentile samples, boys, require more than this percentage of repetitions at both test sessions with the exception of /l/ stimulus words at Session 5 for the 30th percentile sample (19 per cent). For girls, however, at Session 3 and 5 less than 25 per cent of possible repetitions are required for /l/ stimulus words by the 15th and 30th percentile samples, and for /s/ and all stimulus words by the 30th percentile sample.

Shift samples. At both testing sessions the shift samples, boys and girls, require the highest percentage of possible repetitions for the /r/ stimulus words, and least for the /l/ stimulus words. Boys at both sessions require a number of repetitions most similar to that for the 30th percentile sample on /r/ and /s/ stimulus words, and to that for the 50th percentile sample on the /l/ and all stimulus words. Performance of the girls is most similar to that of the 15th to 30th percentile samples at both sessions for all stimulus words.

Phoneme samples. The percentage of possible repetitions required by the several phoneme samples, boys and girls, is highest for the specific phoneme on which the sample was selected for misarticulation at Session 2. The percentage of repetititions of stimulus words for the other phonemes tends to fall at or below 25 per cent of possible repetitions and thus is similar to the percentages of repetitions taken by the 50th and 98th percentile samples. Percentages of repetition of stimulus words evaluating the same phoneme as the designated phoneme sample for boys and girls at both sessions are:

	Session 3		Session 5	
	Boys	Girls	Boys	Girls
/r/	96	82	75	48
/l/	41	--	25	--
/s/	60	68	49	56

These percentages are most similar to those of the 7th or 15th percentile samples, except for the /l/ phoneme sample on the repetition of /l/ stimulus words at Session 5, which is similar to the 50th and 98th percentile samples.

The significance of the differences in the percentages of repetitions of specific phoneme stimulus words by the several phoneme samples is presented in Table 4. For both sexes the number of repetitions of /r/ and /s/ stimulus words is significantly greater for the /r/ and /s/ phoneme samples. For boys the number of repetitions of /l/ stimulus words needed by the /l/ phoneme sample is significantly greater at Session 3 but not at Session 5.

Table 4. Level of Significance of Differences in the Number of Repetitions of Phoneme Stimulus Words Taken in Duplicated Repetition Test by Phoneme Samples, Boys and Girls, at Sessions 3 and 5.

BOYS

	Session 3			Session 5		
Samples	/r/	/l/	/s/	/r/	/l/	/s/
/r/ vs /l/	.01	.01	-	.01	.05	-
/r/ vs /s/	.01	-	.01	.01	-	.01
/s/ vs /l/	-	.01	.01	-	-	.01
GIRLS						
/r/ vs /s/	.01	-	.01	.01	-	.01

1.8 Phonemes in Sentences: Session 11.

In Table A-15 the mean scores for correct production in sentences of the /r/, /l/ and /s/ phonemes and the three phonemes combined are presented for all samples, boys and girls.

The 50th and 98th percentile samples, both sexes, achieved 95 per cent of the maximum on all separate and combined phoneme scores. Mean scores for /r/, /l/, /s/ and for phonemes combined progress steadily from the lower to the higher percentile samples. For boys, differences between all articulation scores achieved by the 7th and 98th percentile samples are significant at the .01 level of confidence. For girls, the single phoneme scores differ between these percentile samples at the .05 level, and the phonemes combined differ at the .01 level.

Scores for the shift sample, boys, most resemble the 7th and 15th percentile samples on /r/, the 15th to 30th percentile samples on /s/ and the phonemes combined, and the 15th to 50th percentile samples on /l/. Scores for the shift sample, girls, most resemble the 7th to 15th percentile samples on /r/, the 15th to 30th on /s/ and the phonemes combined, and the 30th to 98th percentile samples on /l/.

For the several phoneme samples, all scores tend to be above 95 per cent of possible score except the /r/ score for the /r/ phoneme sample, boys (79 per cent), and the /s/ score for the /s/ phoneme samples, boys and girls (72 and 62 per cent respectively). These scores are lower at the .01 level of confidence than the other phoneme scores for the /r/ phoneme sample, boys, and the /s/ phoneme samples, boys and girls. The articulation scores on /r/ and /s/ for the /r/ phoneme sample, girls, are almost identical; the articulation scores on /l/, /r/ and /s/ for the /l/ phoneme sample, boys, are similar.

2.1 Rating of Intelligibility: Sessions 1 through 11.

Mean ratings of intelligibility for each sample and session are presented in Table A-16 for boys and girls. Although most subjects were rated 1 throughout all test sessions, the 7th percentile sample consistently received the poorest rating of all samples. Mean ratings improved from session to session, but some difficulty in understanding subjects still occurred at Session 11 (Mean 1.33, SD .54 for boys; Mean 1.15, SD .45 for girls).

At all testing sessions, mean ratings for the shift sample, boys, tend to be most similar to those of the 15th and 30th percentile samples; those for the shift sample, girls, to those of the 7th to 15th percentile samples.

On the whole, the phoneme samples received good intelligibility ratings at all sessions. The /l/ phoneme sample, boys, at Session 1 received the poorest mean rating for any phoneme sample (Mean 1.23, SD .55).

Articulation Intercorrelations

For each percentile, shift, and phoneme sample, boys and girls, correlations were computed between the nine articulation scores obtained at each testing session on the repeated articulation measures and the Test 1.5, cluster score, taken as the articulation criterion at Session 6 and Session 11. Discussion is based on all correlations, but because of the bulk of the data, only illustrative correlations are included in the appendix. Tables A-18 and A-19 present correlations between articulation criterion scores, Session 6 and Session 11, and Test 1.2, total score, Sessions 1 through 11. Tables A-20 and A-21 present correlations for all samples, both sexes, between articulation criterion scores, Session 6 and Session 11 and each of the nine articulation scores at Sessions 6 and 11 respectively.

Percentile Samples. For all percentile samples, both sexes, the highest correlations between criterion scores and scores on repeated articulation measures tended to be found at the session at which the articulation scores were obtained: i.e. Session 6 for Session 6 criterion scores, and Session 11 for Session 11 criterion scores. For boys, however, at Session 6 ten exceptions occurred in the 45 comparisons (one each at the 7th, 30th and 98th; three at the 15th; and four at the 98th percentile samples). At Session 11 only one exception occurred. For girls, at Session 6 there were two exceptions (one each at the 7th and 50th percentile samples), and no exceptions at Session 11.

Although the magnitude of the correlations between the criterion scores and any single score varies from session to session, there is a tendency for them to decrease at the sessions further removed from that at which the criterion score was obtained.

Table 5. Median r's for Percentile, Shift and Phoneme Samples, Boys and Girls, between Scores on Repeated Articulation Measures and Session 6 and 11 Articulation Criterion Scores.

Session 6 Testing

	Boys			Girls		
Session:	3	6	11	3	6	11
Sample						
7th percentile	.56	.80	.55	.46	73	.22
15th percentile	.31	.60	.45	.34	.75	.33
30th percentile	.20	.81	.34	-.19	.79	.08
50th percentile	.03	.79	.04	.03	.65	-.02
98th percentile	-.37	.38	.18	-.25	.82	.08
Shift	.57	.87	.27	.75	.87	.53
/r/ phoneme	.24	.39	.44	.13	.44	.21
/l/ phoneme	.51	.80	.12	---	---	---
/s/ phoneme	.53	.81	.20	.26	.83	.49

Session 11 Testing

	Boys		Girls	
Session:	3	11	3	11
Sample				
7th percentile	.32	.94	.04	.86
15th percentile	.27	.83	.45	.70
30th percentile	.35	.83	-.12	.57
50th percentile	-.23	.79	.10	.82
98th percentile	.35	.83	.43	.76
Shift	.18	.68	.35	.71
/r/ phoneme	.33	.80	.12	.73
/l/ phoneme	.58	.79	---	---
/s/ phoneme	.11	.47	.08	.81

Table 5 presents, by sex and sample the median of the correlations between articulation criterion scores and the nine articulation scores administered at the same session, and the earliest and/or latest sessions at which the nine articulation tests were administered. Median correlations at Session 1 are not given since they would be based on only four of the nine articulation scores. At Sessions 6 and 11 the correlations range between .60 and .94 with only two exceptions, Session 6, 98th percentile sample, boys, and Session 11, 30th percentile sample, girls. Moderate to substantial median correlations are found for a number of the percentile samples with criterion scores, Session 6 at Session 3 and 11, and with criterion scores, Session 11 at Session 3.

Shift sample. For boys, the highest correlations between the repeated articulation measures and teh criterion scores, Session 6, occur at Session 6 with no exceptions and between articulation scores and the criterion scores, Session 11, at Session 11 with only one exception. For girls six exceptions occur: for correlations between three of the nine articulation scores and criterion scores, Session 6, and for three correlations with criterion scores, Session 11.

Table 5 indicates that median correlations for the shift sample are high between articulation and criteria scores, Session 6, and substantial between articulation scores and criterion scores, Session 11. The magnitude of the median correlations with criterion scores, Session 6, remains high at Session 3 for boys and girls. Median correlation with the criterion scores, Session 11 are low for boys and moderate for girls.

Phoneme samples. Highest correlations were most frequently found at the test sessions in which the criterion scores were obtained for all phoneme samples, boys and girls. In five instances for the /r/ phoneme sample, boys, the highest correlations occurred at sessions other than Session 6. For all other phoneme samples, both boys and girls, with either criterion scores, Session 6, or criterion scores, Session 11 few exceptions occurred.

Table 5 indicates that the /l/ phoneme sample, boys, maintains high median correlations between criterion scores, Session 6 and criterion scores Session 11 and repeated articulation scores at Session 3. For the /r/ phoneme samples, boys and girls, median correlations with criterion scores, Session 11 are high at Session 11, but low to moderate at Session 3. With criterion scores, Session 6, they are moderate at Session 6 and somewhat lower at Session 3. For the /s/ phoneme samples median correlations with criterion scores, Sessions 6 and 11, are moderately high at the session in which criterion scores were obtained. At Session 3, however, only that for boys on criterion score, Session 6, is substantial.

Relation between Articulation and Non-Articulation Measures

The relation between articulation and non-articulation measures was explored by comparison of (1) mean non-articulation scores obtained by the several study samples, and (2) correlations between articulation and non-articulation scores for each of the study samples.

Comparisons of Mean non-Articulation Scores

The 109 non-articulation scores used in this comparison are identified in the description of Measures Used. All non-articulation measures except 2.1 Rating of Intelligibility are included.

Percentile samples. The distribution of mean scores obtained by the five percentile samples, boys and girls, on each of the non-articulation measures was classified as follows:

Category A. Steady increment in mean scores from the 7th to the 98th percentile samples: e.g. Girls, 4.1 Iowa Recognition Spelling Test, adjusted score, means 10.81, 14.80, 16.13, 18.18, 21.71.

Category B. Saltatory increment in mean scores with that of the 7th percentile sample lowest, those of the middle three percentile samples quite similar, and that of the 98th percentile sample highest: e.g. Boys, 4.2 Metropolitan Spelling, means 6.81, 12.38, 12.50, 14.42, 23.42 respectively (Table A-17).

Category C. Either the 7th or the 98th percentile samples receiving the lowest or the highest mean score respectively, with the mean scores for the remaining four samples falling within a relatively narrow range at a different magnitude: e.g. Girls, 3.7 McCullough Syllabification, means 22.42, 25.36, 24.00, 24.64, 25.64 respectively.

Category D. No trend of increase or decrease in mean scores from the 7th to the 98th percentile samples: Boys, 9.5 Porteus Maze, IQ, means 108.96, 114.65, 122.31, 119.84, 112.26 respectively (Table A-3).

The overwhelming number of distributions of scores fall into categories A, B, or C, and thus showed a trend of increase in scores from the 7th to the 98th percentile samples (See Table 6).

Table 6. Distribution of Classification of Trends of Test Scores of Percentile Samples, Boys and Girls by Type of Measure.

	Classification							
	Boys				Girls			
Type of Measure	A	B	C	D	A	B	C	D
2. Speech	4	0	0	2	4	0	1	1
3. Reading	11	9	2	1	13	7	3	0
4. Spelling	3	5	0	0	6	2	0	0
5. Language	1	5	5	4	2	7	4	2
6. Auditory Stimulus	10	17	5	0	11	10	11	0
7. Visual Stimulus	1	5	1	1	4	2	1	1
8. Personality	1	1	1	2	2	0	2	1
9. Intelligibility	1	3	1	4	4	2	1	0
10. Motor	1	0	1	3	2	1	0	2
Total	33	45	16	15	48	31	23	7
Percentage	30.3	41.3	14.6	13.8	44.1	28.4	21.1	6.4

Over 70 per cent of the distributions showed either a steady or a saltatory increase from sample to sample. The differences between the mean scores of the 7th and the 98th percentile samples were significant at the .05 or the .01 level for about 75 per cent of the scores; at the .01 level for about 50 per cent of the scores. The significant differences were found for both sexes at all test sessions and on all types of tests.

Table 7. Test Scores Classified D, No Trend for Percentile Samples, Boys and Girls.

Session	Test and Score	Boys	Girls
3	2.3 Speech in Family Relations I	X	X
9	2.4 Speech in Family Relations II	X	
11	3.11 Homographs: No Reading Difficulty	X	
8	5.5 Sentence Completion: Number of Words	X	X
	Number of Difficult Words		X
10	5.6 Word Association: Both Sex Norms	X	
	Boys Norms	X	
	Girls Norms	X	
4	7.2 Murphy-Durrell Matching Letters	X	X
10	8.2 Bender Gestalt: Emotional	X	X
8	8.5 Teacher's Rating: Listening	X	
11	9.5 Porteus Maze: TA	X	
	TQ	X	
11	10.1 Stambak Rhythm: Tapping 1	X	X
	Tapping 2	X	X
	Items 1-21	X	

The specific tests that were classified in Category D are listed in Table 7. The scores showing no increment over the percentile samples ranged widely in the test sessions in which they were administered, and among the types of measures. Among such scores for both sexes, are those that are near the maximum (Measure 7.2) those which could be expected to be quite unrealted to articulation performance, (Measures 8.2, 10.1) and those from tests constructed for this project (Measures 2.3, 2.4 and 5.5).

Shift sample. The magnitude of each mean non-articulation score obtained by the shift samples, boys and girls, tended to fall between those obtained on a particular measure by the 15th to the 98th percentile samples on the same score. The exceptions that occurred were not many, and occurred mostly for those scores in which steady increment for the percentile samples did not occur or was not statistically significant: e.g. low mean scores on Measure 5.5, number of words and number of different words, and high mean score on Measure 7.2, for boys. No tendency was found for mean scores to be higher or lower either on a particular type of non-articulation measure such as reading or language, or at a particular time in the testing period from Sessions 1 through 11.

Phoneme samples. Mean non-articulation scores obtained by the several phoneme samples tend to be quite similar. Only in a few scattered instances do they differ significantly at the .05 level of confidence. No pattern of differences in mean scores for either boys or girls emerged according to type of measure, time of administration or specific phoneme sample. It should be pointed out, however, that on many of the measures, the order of magnitude of mean scores, from highest to lowest, was received by the /r/, /s/ and /l/ phoneme samples for boys, and by the /s/ and /r/ samples for girls.

Correlations: Articulation vs. Criterion Scores

For all samples correlations were computed between scores on articulation tests at all sessions and criterion spelling scores, Session 8, and criterion reading scores, Session 11. Discussion is based on all correlations, but representative sets of correlations are presented in appendix. Tables A-22 and A-23 present correlations between Test 1.2, total scores at all sessions and Test 4.2 Metropolitan Spelling score, Session 8 and Test 5.2 Gates Reading Survey, total score, Session 11, respectively. Tables A-24 and A-25 present correlations between the criterion spelling and reading scores and all articulation scores at Sessions 8 and 11, respectively.

Percentile samples. The magnitude of the correlations between articulation scores and both spelling and reading criterion scores fluctuates from session to session with no tendency for the higher correlations to be found at the session in which the criteria scores were obtained. A substantial portion of the correlations obtained are negative.

Table 8 presents by sex and sample, the median of the correlations between spelling and reading criterion scores and the nine articulation scores administered at the same session and the earliest and/or last session at which the articulation measures were administered. The median correlations between articulation and spelling criterion scores for Sessions 3, 8 and 11 show no pattern of variation for boys or girls. The median correlations are low, and only for the 7th percentile samples, boys and girls, are the signs of the median correlations positive at all three sessions.

The median correlations between articulation and reading criterion scores for Sessions 3 and 11 are low with only three exceptions. (See Table 8.) The median correlations for the 7th percentile sample, boys, reflects a range of correlations from .12 to .45 at Session 3 and from .45 to .57 at Session 11. The median correlation for the 30th percentile sample, girls, reflects a range of correlations from +.28 to -.53.

Table 8. Median Correlations between Articulation Scores and Spelling Criterion Scores, Session 8, and Reading Criterion Scores, Session 11, at Selected Sessions for All Samples, Boys and Girls.

	4.2 Spelling, Session 8			5.1 Reading, Session 11	
BOYS Sessions:	3	8	11	3	11
Sample					
7th percentile	.14	.29	.26	.34	.55
15th percentile	.17	.24	-.10	.09	.03
30th percentile	.23	-.29	-.07	.09	-.02
50th percentile	.11	.01	-.27	.07	-.02
98th percentile	.07	.13	-.05	.23	-.02
Shift	-.03	.18	-.05	.06	.15
/r/ phoneme	.03	-.08	-.19	-.07	-.11
/l/ phoneme	.15	.18	.03	.23	-.11
/s/ phoneme	.12	-.31	-.43	.31	-.44
GIRLS					
Sample					
7th percentile	.17	.23	.17	.11	.14
15th percentile	.19	-.01	.16	.22	.20
30th percentile	-.21	.12	.27	-.34	.13
50th percentile	.00	-.17	.14	.05	.15
98th percentile	-.11	-.40	.05	-.00	.07
Shift	.33	.43	.28	.54	.43
/r/ phoneme	.06	-.01	.36	-.06	.40
/l/ phoneme	---	---	---	---	---
/s/ phoneme	.41	.07	.01	-.08	-.03

Shift samples. Although the median correlations for boys on both spelling and reading are slightly higher at the session in which the criterion scores were obtained, they are low at all sessions. For girls, however, median correlations bor both spelling and reading at the several sessions are consistently moderate.

Phoneme samples. The median correlations for the phoneme samples, boys and girls, vary from session to session with only the /r/ phoneme sample, girls, obtaining a moderate positive median correlation at the session at which a criterion measure was obtained (Reading, Session 11, .40).

Correlation: Criterion Articulation vs. Non-Articulation Scores

For each sample, boys and girls, correlations were computed between the articulation criterion, Test 1.5, cluster score, Session 6 and Session 11, and 101 quantitative non-articulation scores. Although the magnitude of the correlations varied greatly, most of the correlations fell within the range between ± .20. Moderate to relatively high correlations tended to concentrate in a few samples for the Session 6 and Session 11 articulation criteria. Approximately one-third or more of the correlations computed for the following samples ranged between .30 and .72: 7th percentile sample, boys (45 correlations), 15th percentile sample, boys (31), /l/ phoneme sample, boys (61), shift sample, girls, (53) and /r/ phoneme sample, girls (37) with the Session 6 articulation scores; and 7th percentile sample, boys (67 correlations), shift sample, girls (34), and /r/ phoneme sample, girls (41), with the Session 11 articulation criterion scores.

DISCUSSION

Samples for study were initially selected in kindergarten according to (1) the number of misarticulations (percentile samples), (2) the single phoneme consistently misarticulated (phoneme samples), and (3) the extent of variation in articulation test scores according to method of eliciting the utterance in which the sounds were evaluated (shift samples). These characteristics of articulation were considered because they were believed to be relevant to the problems of prediction of adequate articulation, and thus to the recurring questions of identifying subjects for speech therapy in the early grades, and of defining an articulation deviation in kindergarten. This longitudinal study has demonstrated that these aspects of articulation performance are useful in delineating differences in change of articulation scores through the fourth grade.

In this longitudinal study, the samples selected for study, both boys and girls, reached different levels of articulation proficiency at the end of the fourth grade. Cross-sectional studies consistently have reported that mature or adequate articulation was achieved by children at seven or eight years of age. Templin in her normative study assumed adequate articulation for a sample when mean scores were at about 95 percent of the possible score on an articulation test. Adequate articulation, as thus defined was attained by the different samples at widely different ages. While the 50th percentile samples (a built-in normative sample) achieved adequate articulation at about the ages expected from cross-sectional data, the 98th percentile samples had attained this level by the earliest testing, at four-and-a-half years, and the 7th and 15th percentile, and the /s/ phoneme samples for both boys and girls had not achieved this level at the last testing session when the subjects were nearly ten years old.

The percentile samples maintained the same relative positions from 98th to 7th on their mean articulation scores through Session 11 or until a sample mean approached 95 per cent of possible scores. For successively lower percentile samples this level was reached, if at all, at respectively later testing sessions. Even at the last testing session the mean scores of the 7th percentile samples were significantly below those of the upper two percentile samples for the boys and the upper three samples for the girls.

Among phoneme samples studied, differences are neither as pronounced nor consistent, but the possibility of some difference in the course of development for samples of children with different primary phoneme misarticulation is suggested. No /l/ phoneme sample could be identified for girls in kindergarten, and this phoneme sample achieved adequate articulation at earlier sessions than other phoneme samples for boys, while /s/ phoneme samples have not achieved adequate articulation for both sexes at Session 11.

The pattern of misarticulation of specific phonemes over time has not been examined although data are available for such investigation. The performance of the specific phoneme samples on tests of duplicated repetition (Test 1.7) and articulation of phonemes in sentences (Test 1.8) suggests, however, that misarticulation of specific phonemes tend to persist for groups. On these tests, administered just after sample selection (Session 3), a year later (Session 5) and four years later (Session 11) scores for each phoneme sample tended to be poorer for the subscore on the same phoneme that had been the primary misarticulation in kindergarten.

Based on results of cross-sectional study, it had originally been planned to terminate longitudinal testing when children at-grade were in the second grade. At that time, however, it was necessary to extend the period of testing because a much larger number of children than anticipated did not adequately produce the phonemes of English. Now, at the conclusion of the eleventh testing session, it is evident that if the course of articulation development of samples of subjects with the most misarticulations and with primary /s/ phoneme misarticulations in kindergarten is to be traced to adequate production, it is necessary to continue testing beyond the fourth grade.

When the shift samples were selected it was expected that their articulation scores would increase rapidly and that they would attain adequate articulation during the early testing sessions. This hypothesis was based on studies that reported subjects with inconsistent picture and imitation articulation test scores improving more over a six-month period than those with consistent scores (10, 51, 52, 53). It is also logical to expect children who have demonstrated that under certain conditions they can produce sounds more accurately, soon to do so consistently. However, the shift samples did not improve rapidly in their articulation scores. Throughout the testing sessions the mean articulation scores of the shift samples vary, for the most part, between the means of the 15th and 30th percentile samples. Even at Session 11, mean scores for boys fall between those of these two samples, and those for girls between the mean scores of the 15th to 50th percentile samples. Thus, not only is the hypothesis not supported, but the analysis has pointed to relatively slow change in mean articulation scores from kindergarten through fourth grade.

The hypothesis was also not supported in the prediction aspect of the larger project (60). On three separate criteria in second grade proportionately more subjects were identified as needing speech therapy when their kindergarten picture and imitation scores differed 4 or more centile points than when their scores were similar. For girls the proportion was significantly higher on all three criteria at the .05 or .01 level of confidence; for boys it was significant on one criterion at the .01 level. The subjects in both the prediction and the longitudinal studies are the same with the exception of three who were lost from the sample between second and fourth grades.

Two possible explanations of the unexpected results considered in the earlier report are still valid and there is no known additional evidence for their acceptance or rejection. One is that in this project more extreme shifts in articulation scores may be represented than in other studies, since only around four percent of the subjects from which the longitudinal study sample were drawn differed as much in their kindergarten picture and imitation tests as the criterion for sample selection. Another possible explanation is that since the picture and the imitation tests elicit test words through perceptual and cognitive channels, the results may tap discrepant perceptual and cognitive functions and thus be associated with learning disabilities. A third possible explanation is based upon the mean articulation and non-articulation scores of the shift sample throughout the eleven testing sessions in the longitudinal study. Since these scores tend to resemble those of the middle percentile samples throughout, it may be that discrepancy between picture and imitation scores in kindergarten is not a relevant classification for selection according to the purposes of the longitudinal study.

In any event, the findings differ from the expected, and further investigation is needed because of their potential psychological and educational value. Using data presently available, at least two investigations are immediately indicated: (1)Reexamination of the classification of subjects into the shift samples. The classification that was used considered the percentage of possible picture and imitation score and not scores based only upon items evaluated in both picture and imitation tests. (2) The repetition of the prediction study analysis on a new sample. Among the subjects in the prediction study first tested at kindergarten (See Figure 1) those with discrepant picture and imitation scores have not been identified and their performance has not been analyzed separately.

When mean scores on non-articulation measures attained by the several study samples were compared, it was found that they varied systematically among the percentile but not the phoneme samples.

Among the percentile samples higher mean scores were obtained by the samples selected as having fewer misarticulations in kindergarten. The trend is evidenced either in regular increments from the lowest to the highest percentile samples or in various patternings in which scores of the highest and the lowest percentile samples differ. It is found in about 85 per cent of the comparisons for boys and in over 90 per cent of the comparisons for girls when all categories of tests (i.e. speech, spelling, reading, etc) and all testing sessions are considered. In many instances the magnitude of differences in mean scores between the extremes of the percentile samples is significant.

The finding that the highest and lowest percentile samples quite consistently obtained the best and the poorest mean non-articulation scores over the eleven testing sessions was not expected. Recently, Wepman and Morency (72), considering many of the same non-articulation areas, have reported no significant differences at first, second or third grade in mean scores of subjects initially selected with acceptable and unacceptable articulation in first grade. The differences between the findings of these two studies are pronounced. Because both are concerned with the general problem of deviation in the early school years it is particularly important to resolve, or explain, apparent differences in results.

Explanation of the differences between the studies is not found in the non-articulation areas considered, since there is much overlap in the areas and some in specific tests used. There are, however, some important differences in the characteristics of the samples studied. In the present study three samples of subjects selected with below median articulation at kindergarten were followed through fourth grade. The 154 subjects remaining in the 7th, 15th and 30th percentile sample at fourth grade were selected from some 1500 children in 45 schools. Over the five-year span of the study only about ten per cent of the subjects were lost over all study samples. In the Wepman and Morency study one sample of subjects with unacceptable articulation at first grade was followed through third grade. The 66 subjects who remained in the unacceptable articulation group were selected from 259 subjects in two schools. The effect of the loss of nearly 25 per cent of the sample in the subjects who moved from the community over the two-year span is not known.

Both studies attempted to eliminate subjects whose poor articulation had organic etiologies such as hearing loss or low intelligence. In addition 10 subjects were eliminated from the Wepman and Morency study because of patterns of articulation that were considered inappropriate for age according to previous work. Some such subjects were probably indirectly eliminated in the present study because of known organic deviations associated with speech, but patterns of articulation were not systematically examined for their direct elimination.

All of these factors would tend to restrict the range of articulation deviations of the subjects studied. It is likely that the subjects with unacceptable articulation in the Wepman and Morency study would fall between the 15th to 50th percentile samples in the present study, and would probably most resemble the 30th percentile sample. Scores of this sample throughout the study did not differ significantly from those of the 50th and, in many instances, the 98th percentile samples. It is interesting to contrast findings on intelligence measures. Wepman and Morency found no differences between groups with acceptable and unacceptable articulation. In this study, scores of the 15th, 30th and 50th percentile samples are similar, and only the extreme highest and lowest percentile samples differ significantly.

The investigation of the relation between articulation and performance on non-articulation variables should be extended for a longer period of time with the longitudinal sample. In addition characteristics of found relations need to be delineated according to test content, level of articulation, etc. Some of the latter analyses have been carried out with available data from the longitudinal study.

One of the completed more detailed analyses of longitudinal data that are not included in this report gives support to the relation between articulation and ability to apply the rules of morphological change. A 2 x 3 x 5 analysis of variance of total Berko morphology scores (Test 5.2) administered at three sessions indicates significant differences among the percentile samples at the three sessions, and between sessions at the .01 level of confidence but no significant differences between the sexes. On the other hand, while mean commonality word association scores obtained at Session 6 vary according to percentile samples, those obtained at Session 10 do not.

The magnitude of correlations among articulation and non-articulation scores, calculated for each percentile, phoneme and shift sample varies considerably from sample to sample. Although for many of the samples most correlations are in the low positive or negative range, for some samples a substantial number of moderate to moderately high correlations are found, e.g. the lower percentile samples for both sexes and the shift sample for girls. While it is recognized that some of the variation in the magnitude of correlations reflects differences in the range of the same scores among the samples, this is not a complete explanation, since the magnitude of correlations varies for samples in which the range of scores is quite similar.

The finding that correlations tend to be of greater magnitude among certain samples selected in kindergarten according to different articulation characteristics is of value. It reemphasizes the importance of the sample studied, aids in the interpretation of varying research results, and suggests a focus for selection of research samples.

Although differences in the performance of boys and girls was not systematically evaluated in this study, some observations on it are made because of long-continuing interest in the topic. Mean articulation scores of the populations of boys and girls from which longitudinal samples were selected for study differed sufficiently at kindergarten so that selection was based on the separate distributions for each sex. Good articulation, when it is achieved, is similar for boys and for girls. Thus no sex differences appear when mean scores for any particular sample approached 95 per cent of maximum score (e.g. at all sessions for the 98th percentile sample, and less frequently at later testing sessions).

CONCLUSIONS AND IMPLICATIONS

The following conclusions are drawn from results of the completed analyses of the data.

1. The three aspects of articulation performance that were the basis for sample selection in kindergarten (number of misarticulations, type of misarticulation, and divergent picture and imitation articulation scores) have proved useful for delineating longitudinal patterns of development of articulation from prekindergarten through the fourth grade.

2. While cross-sectional studies have consistently found adequate articulation achieved at seven to eight years of age, the 98th percentile samples, both boys and girls, had already attained such articulation at the first testing session (i.e. at four-and-a-half years of age) the 50th percentile sample attained it at about the expected ages; the 7th percentile samples had not attained it and the /s/ phoneme sample approximated adequate articulation at the last testing session (i.e. at nearly ten years of age).

3. The several percentile samples maintained their relative positions on mean articulation scores from Session 1 through Session 11 or until mean scores had reached about 95 per cent of the possible score.

4. Although developmental differences in mean articulation scores for the phoneme samples are not pronounced in relation to actual scores, they do suggest that subjects with /l/ as the primary misarticulation in kindergarten achieve adequate articulation somewhat earlier than those with /s/ as the primary misarticulation. Performance of the several phoneme samples also suggests the longer persistence of the misarticulation of /s/.

5. The articulation scores of the shift samples did not increase rapidly in the earlier testing sessions as had been expected, but rather, throughout the study their mean scores were similar to those of the middle percentile samples.

6. Correlations between articulation criterion scores, Session 6 and Session 11 and other articulation scores are substantial, and highest at the session in which the criterion score was obtained.

7. Mean non-articulation scores for the various percentile samples, boys and girls, tend to vary throughout the five years of testing so that the best scores are obtained by the highest percentile sample and the poorest scores by the lowest percentile sample.

8. While correlations between articulation and non-articulation scores are, in general, low and variable, they tend to vary from moderate to moderately high correlations within certain samples, particularly the 7th percentile and shift samples for boys and girls.

9. Some difficulty in understanding a child is more likely to be associated with a larger number of misarticulations than with the consistent misarticulation of a single sound.

The problem of selection of cases for speech therapy is, of course, intimately related to the prediction of articulation development and thus to a definition of articulation deviation during the early school years. If progress toward the resolution of the problem of prediction is to be made, a number of different attacks are probably necessary. One, surely, is to study those articulation deviations that are most likely to make it possible to delineate factors that influence articulation development. This longitudinal study has identified several samples in which inadequate articulation continues to persist for a longer period of time. This suggests that the samples on which to focus intensive study should probably be composed of children who in kindergarten have the greatest number of misarticulations, who have divergent picture and imitation articulation scores and specific primary misarticulations, particularly the /s/ phoneme.

Since some samples selected with certain initial characteristics of articulation were still developing adequate articulation considerably later than others, these characteristics - the number of misarticulations, substantial difference in picture and imitation articulation scores, and primary phoneme misarticulation - might well be important in case selection. However, these characteristics have been developmentally identified, and the effect of therapy upon the rate of progress toward adequate articulation has not been determined.

While information on the effect of therapy is an essential aspect of the problem of case selection, the effectiveness of therapy during the development of articulation is not known. The value of therapy at this period is a moot question. Although it has not been systematically explored in this study, the articulation scores of subjects who had had some therapy fell well within the range of those in their particular sample who had had no therapy. This finding, however, does not mean that therapy directed toward specific aspects of articulation at crucial points in development might not be effective. This possibility needs to be investigated.

Observed differences in the rate of development of the several selected samples has emphasized the importance of the particular sample studied to the research results obtained. This fact is an aid in understanding and explaining some of the seeming conflicting findings reported in the research literature. It has, too, considerable importance for the interpretation and application of results of studies carried on with subjects from clinical and non-clinical populations.

The study suggests that a clustering of positive performances in subjects with the best articulation in kindergarten, and of negative performances in subjects with the poorest articulation in kindergarten is present at school entry and persists over the five year span of the study. Thus the 98th percentile samples, even though some regression may occur had adequate mean articulation scores and the highest mean intelligence and other non-articulation scores throughout the study. The 7th percentile samples, on the other hand, had the lowest articulation, intelligence and other non-articulation scores, and showed more substantial correlations between them than found in most other samples.

Clustering of positive traits was reported over forty years ago when many were found to be associated with high intelligence (66). Something similar may be occurring at both ends of the spectrum when articulation of kindergarten children is at least a year-and-a-half inferior or superior to that expected from cross-sectional studies. Since selecting children on the basis of number of misarticulations selectively draws with it other scores, it may be that articulation tests, which can be administered in less than ten minutes, should be included in early evaluations of children. Surely, the possible diagnostic function of a kindergarten or prekindergarten articulation evaluation needs to be further explored.

The gross analyses of the longitudinal data have suggested that findings are sufficiently relevant to the problems of prediction and case selection that research effort should be spent on identifying characteristics that are associated with differential development of subjects within the samples that are slow to attain adequate articulation.

SUMMARY

The major objectives of the longitudinal study reported here are (1) the description of the development of articulation of consonant phonemes through the fourth grade or until adequate articulation is achieved, and (2) the exploration of the relation between articulation and non-articulation variables. It is part of a project concerned with the general problem of prediction of articulation development or deviation into which longitudinal, prediction and a number of ancillary studies are incorporated.

For this longitudinal study, selected subjects were tested in eleven sessions at six-month intervals over a five year period from the spring before kindergarten entrance through the fourth grade. At Session 1 the articulation of about 1500 subjects was evaluated both in words elicited by pictures and by imitation with an aural model presented by the examiner. The larger number of subjects provided the pool from which to select subjects with characteristics of articulation that were considered important for the problem of prediction of articulation. The characteristics considered were (1) substantially diverging picture and imitation test scores, (2) the number of misarticulations, and (3) the specific misarticulation. Samples identified for study were:

One shift sample made up of those subjects among the 1500 tested at kindergarten whose picture and imitation articulation scores differed four or more centile points.

Five percentile samples made up of subjects whose total articulation scores were non-overlapping, and clustered around the 7th, 15th, 30th, 50th and 98th percentiles on the distributions.

Three phoneme samples made up of subjects in which the misarticulation of either /r/, /l/ or /s/ was the single major misarticulation.

Potential subjects for the longitudinal study samples were chosen by procedures that took into account the consistency of picture and imitation articulation scores for individuals and the distributions of both picture and imitation scores for both boys and girls. From the pool of potential subjects those children were eliminated who were known to have organic deviations related to speech production, e.g. hearing loss, malformation of the speech mechanism or known mental retardation. Then subjects for the final study samples were chosen using a technique of random selection. It was not possible to include an /l/ phoneme sample for girls, since only five potential subjects were identified. Approximately equal numbers of boys and girls were chosen for all other final longitudinal study samples.

All subjects were given a sweep check audiometer test as part of the Minneapolis public school program or by the Minneapolis Division of Public Health. Subjects at Session 1 were drawn from 45 Minneapolis public schools and those remaining at Session 11 were in 131 public and parochial schools in Minneapolis and the suburbs. Parents had brought the prekindergarten children to the schools for the initial testing.

The samples for analysis in a longitudinal study are determined by the subjects remaining at the last testing. At Session 11, the samples included 436 subjects, 223 boys and 213 girls, of whom 400 were in fourth grade, 2 in fifth, 28 in third and 6 in special classes. No subjects were dropped from the study because of enrollment in speech therapy, or because they had a hearing loss. Fifty subjects had been lost during the five years of the study over all samples: 44 had moved out of the area, six were dropped because of illness, on request of parents, or principal, etc.

The final study samples were quite similar although some differences were apparent. The ranges in mean scores for all samples of boys were as follows: CA, between 56.9 and 60.2 months; WISC Full Scale IQ, between 95.2 and 112.6; position in family, between 1.9 and 2.8; number of siblings, between 2.7 and 3.8. The ranges for girls were very similar. The modal socioeconomic status of all samples as classified on the Hollingshead Two-Factor Index was 3 or 4. The extremes of the ranges are found in either the percentile, shift or phoneme samples. However, there is a tendency within the percentile samples, both boys and girls, for the higher CA, IQ and socioeconomic status and the lower number of siblings and position in the family to be found for the higher percentile samples.

At each testing session, articulation was assessed by a number of measures evaluating the production of consonant phonemes and consonant clusters in the initial and final positions in nonsense and in English words. The description of the development of articulation was based on nine scores obtained at repeated testings: 1.2 Prekindergarten Articulation Test, total, initial consonant, final consonant and total consonant scores, Sessions 1 through 11; 1.4 Kindergarten Imitation Articulation Test, total score, Sessions 3 through 11; 1.5 Long Articulation Test, cluster score, Sessions 3 through 11; 1.6 Spencer Nonsense Word Articulation Test, initial consonant, final consonant and total consonant scores, Sessions 3, 5 through 11. Also included in the analyses were 1.8 Duplicated Repetitition Test, total score, and /l/, /r/ and /s/ subscores, and 1.9 Phonemes in Sentences, total score, and /l/, /r/ and /s/ subscores. The former was administered at Sessions 3 and 5, the latter at Session 11.

At selected sessions tests were administered in the general areas of speech, reading, spelling, language, auditory stimuli, visual stimuli, personality, intelligence and motor areas. These included standardized tests (e.g. Metropolitan Spelling Test and the Gates Reading Survey) as well as tests constructed especially for this study. From some 65 measures 101 quantitative scores were used in the analyses. A few measures that were administered were excluded from the analyses, because data from them were not appropriate or ready for use in them.

All articulation tests were administered by graduates in speech pathology, for the most part at the Master's level and with some public school experience. Intelligence tests were given by qualified psychometrists. All other measures were administered by speech clinicians, or persons with backgrounds in psychology or education. The basis for sample and subject selection was not known to the examiners.

Analyses made for each sample separately were simple, and largely descriptive. They include comparisons of the significance of the differences between mean scores for the percentile, shift and phoneme samples, and comparisons of patterns of correlations computed among articulation scores and between articulation and non-articulation scores for each sample. Scores that reach ninety-five per cent of maximum are taken to indicate adequate articulation.

Results

I. Results of the analyses of articulation development.

1.1. The patterns of change on the repeated measures of articulation differ among the samples, but are quite consistent within each sex for the nine scores.

1.2. On all articulation scores the relative positions of the percentile samples remain the same from Session 1 through Session 11 or until approximately 95 per cent of the maximum of any particular score was reached.

1.3. Among the several percentile samples there is a wide range in the age at which mean adequate articulation is attained: the 98th percentile, both boys and girls, had already attained such articulation at Session 1 (i.e. at four-and-a-half years of age); the 50th percentile attained this level at about Session 6 to Session 8 (at approximately the seven or eight years reported for cross-sectional studies); and the 7th percentile had not attained this level of articulation at Session 11 (when subjects were nearly ten years old).

1.4. Shift samples did not improve rapidly in articulation during the early testing session as had been expected. Rather, throughout the testing period scores for boys and girls tended to resemble those of the 15th to 30th percentile samples. At Session 11, girls, on all measures, and boys on some, had attained adequate articulation.

1.5. Differences are not pronounced for the phoneme samples. However, in general the /l/ phoneme sample, boys, achieved adequate articulation at about the same sessions as the 50th percentile sample. (No /l/ phoneme sample was identified for the girls.) The /r/ phoneme samples, both sexes, reached adequate articulation a few sessions later, and the /s/ phoneme samples, boys and girls, had just about attained it at Session 11.

1.6. Correlations between 1.5 Long Articulation Test, cluster score, the articulation criterion at Session 6 and Session 11 and the other repeated articulation scores were highest at the session in which criterion scores were obtained (moderate to high, with many over .80). Correlations, in general, tended to be highest for the lower percentiles and shift samples, boys and girls, and to vary with sex and session among the phoneme samples.

1.7. On the 1.7 Duplicated Repetition Test administered at Sessions 3 and 5, the 50th and 98th percentile samples required less than 25 per cent of the possible repetitions, and the lower percentile samples a higher percentage. The 7th percentile samples needed the highest percentage of repetitions: over both sessions from 47 to 89 per cent for boys, and from 33 to 86 per cent for girls. The /l/ phoneme and shift samples, boys, resembled the performance of the 50th percentile sample. The percentage of repetitions required by the separate phoneme samples varied for the /r/, /l/ and /s/ stimulus words. In most instances the greater percentage of repetitions needed for the specific phoneme stimulus words by the phoneme sample (e.g. /s/ stimulus words by the /s/ phoneme sample) was significant at the .01 level.

1.8. In 1.8 Phonemes in Sentences, administered at Session 11, the percentile samples maintained their relative positions; the shift samples resembled the 15th to 30th percentile samples; the several phoneme samples (on total scores) resembled the 15th to 30th percentile samples, but on the subscore for the phoneme that was the same as the phoneme sample (e.g. /s/ phoneme and sample) most resembled the 7th to the 15th percentile samples.

1.9. For any sample at any session, comparatively few ratings of intelligibility were given that indicated moderate or extreme difficulty in understanding a subject. However, the 7th percentile samples received more, and even at Session 11 some such ratings were found. With only one exception, all phoneme samples recieved a better mean intelligibility rating at Session 1 than the 7th percentile sample at Session 11.

II. Results of analyses of the relation between articulation and non-articulation measures.

2.1. The 7th percentile sample had the lowest mean non-articulation scores and the 98th percentile sample had the highest. Of the 109 non-articulation scores only on 14 per cent of the boys and on 7 per cent for the girls did this occur. About 75 per cent of the differences between the mean scores of the 7th and the 98th percentile samples were significant at the .05 or .01 level of confidence. No pattern of differences were identified for the phoneme samples. In most instances the scores for the shift samples fell within the range of the scores of the percentile samples.

2.2. Correlations between 4.2 Metropolitan Spelling, criterion score at Session 8 and articulation scores are of low order and fluctuating, except for a few samples, particularly the 7th percentile samples, boys and girls, and the shift sample, girls. Correlations are not higher at Session 8, the session at which the criterion scores were obtained.

2.3. Correlations between 3.1 Gates Reading Survey, criterion score, Session 11, and articulation scores are low except for the 7th percentile sample, boys, and the shift sample, girls.

2.4. Correlations between 1.5 Long Articulation Test, cluster score, articulation criterion, Session 6 and Session 11, and non-articulation scores, for the most part, fell between ± .20 although moderate to moderately high correlations tended to be concentrated within a few samples. Between one- and two-thirds of the correlations computed within the following samples fell between .30 and .72: with criterion score, Session 6, the 7th and 15th percentile and /l/ phoneme samples, boys, and the shift and /r/ phoneme samples, girls; with the criterion score, Session 11, the 7th percentile sample, boys, and the shift and /r/ phoneme samples, girls.

The study has shown that samples of subjects selected on the basis of three aspects of articulation have followed patterns of longitudinal development that can be differentiated. Samples of subjects with most misarticulations in kindergarten have maintained the relatively poorest articulation throughout the five years of the study, and have not attained adequate articulation at the end of fourth grade.

The shift samples that in kindergarten had demonstrated ability to improve total articulation when an aural model was presented, did not improve as rapidly over time as had been expected. Rather, these samples had performed quite similarly to the 15th and 30th percentile samples throughout the period of testing.

The performance of the phoneme samples cannot be sharply separated, but there are suggestions that the subjects with /l/ as the primary misarticulation in kindergarten tended to achieve adequate articulation earliest, those with /r/ as the primary misarticulation next, and that those with /s/ as the primary misarticulation had nearly attained adequate articulation by the end of the fourth grade.

Suggestions for Further Research

Although in planning and carrying out this longitudinal study many questions and hypotheses have been identified, only a few studies are proposed for further research. Those are mentioned because they seem likely to provide either needed information on articulation development and prediction, or basic information on related non-articulation variables. Some suggestions require the collection of additional data, and others various uses of data now available on the longitudinal subjects.

1. Another testing session should be carried on with the subjects in the longitudinal samples as soon as possible. This would permit (1) tracing the later articulation development of those subjects who had not attained adequate articulation at Session 11, and (2) providing information of the possible persistence of differences in non-articulation performance between the extremes of the percentile samples. Although follow-up should ideally have been carried out at yearly intervals, it is still possible to test the subjects within three and a half years after Session 11. These children should be tested to maximize the value of the observations already made by increasing, meaningfully, the length of time over which changes in performance are observed.

2. Systematic study of prediction and development of articulation should be carried on with samples of children in those categories of articulation performance that have been shown to take a longer period of time to attain adequate articulation. These include children with the highest number of misarticulations of non-pathological etiology, with divergent picture and imitation articulation scores, and with primary single phoneme misarticulation, especially the /s/ phoneme. High priority should be given to

studies that attempt to delineate factors that differentiate those subjects who do and do not spontaneously improve in articulation within these samples.

3. Subjects with divergent picture and imitation articulation scores in prekindergarten and kindergarten should be studied intensively to explore the etiology of the divergent scores, and their possible relation to learning and behavior disabilities.

4. The effect of therapy upon identified patterns of articulation deviation at selected points in development should be investigated to provide more refined information of techniques and procedures for speech therapy.

5. In this report only gross scores have been considered. However, more detailed analyses of some measures, and the use of others that have not been included in the analyses is indicated. Following are some proposed relevant investigations:

5.1 A detailed description of the longitudinal development of the change in articulation over time in which distinctive features, specific phonemes and types of phonemes are considered.

5.2 Detailed analyses of the characteristics of word association responses, and their changes between second and fourth grade; the relation of word association responses to articulation and other language performance.

5.3 Analysis of Test 8.8 Parent Questionnaire and, particularly, specific parts as they relate to children's articulation status or development. Information is available on parental standards and practices and on general development of the children.

5.4 Investigation of relations between selected non-articulation and/or articulation variables, e.g. the relation between performance on selected visual and auditory stimulus measures to errors in reading words (Tests 3.2 and 3.3) classified both according to reading (visual) and speech (auditory) characteristics.

5.5 A number of tests have yielded substantial language output, e.g. TAT, CAT and essays. These, for example, provide data to determine characteristics of spontaneous language of children with different early patterns of articulation and specific comparisons such as that between the application of morphological rules in spontaneous language and Test 5.2 Berko Morphology Test.

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Table A-1. Background Information: Chronological Age; Intelligence; Position in Family; Number of Siblings; and Socioeconomic Status. Means and Standard Deviations or Modes for Boys and Girls by Samples.

BOYS		CA*		WISC Full Scale@		Position in Family*		Number of Siblings*		SES*
Sample	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	Mode
7 %ile	27	58.63	2.48	95.15	14.09	2.74	1.20	3.52	1.42	4
15 %ile	26	59.27	3.76	101.92	15.71	2.65	1.24	3.54	1.71	4
30 %ile	26	57.88	2.94	104.77	12.01	2.38	1.27	3.38	1.30	4
50 %ile	38	58.39	2.90	101.63	12.04	2.66	1.69	3.53	2.06	4
98 %ile	19	60.21	3.82	112.58	12.73	2.53	1.50	3.11	1.29	4
Shift	22	57.50	3.04	103.32	13.10	2.64	1.07	3.82	1.23	4
/r/	25	60.08	3.36	107.96	12.72	2.80	1.13	3.40	1.33	3,4
/l/	17	56.94	3.21	103.65	12.17	1.94	.73	2.71	.89	4
/s/	23	59.09	4.12	105.87	13.13	2.26	1.45	3.61	1.63	4
GIRLS										
Sample										
7 %ile	26	56.85	3.22	93.85	10.67	3.19	1.62	4.08	1.79	4
15 %ile	25	57.32	3.03	100.44	11.04	2.72	1.25	3.92	1.47	3,4
30 %ile	24	58.08	3.30	102.33	13.21	2.67	1.37	3.75	1.45	4
50 %ile	33	58.42	3.34	102.33	10.64	2.57	1.26	3.61	1.41	4
98 %ile	28	59.96	3.80	111.11	10.24	2.43	1.50	3.36	1.39	3
Shift	28	57.18	3.63	99.82	16.17	2.64	1.31	3.61	1.57	3
/r/	24	56.83	3.14	108.04	12.45	2.58	1.19	3.37	1.28	4
/l/	--	-----	----	------	-----	----	----	----	----	-
/s/	25	58.56	3.45	104.60	13.74	2.76	1.42	3.60	1.57	4

* At Session 1.

@ Tested between Sessions 9 and 10.

Table A-2. Differences in Months in Mean Chronological Age Between Consecutive Testing Sessions for Boys and Girls by Samples.

		Testing Sessions									
BOYS Sample	N	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11
7 %ile	27	5.2	6.4	6.2	5.0	6.1	6.3	5.9	5.9	6.0	6.0
15 %ile	26	4.8	6.7	6.2	5.5	5.9	6.0	6.1	6.4	5.8	6.3
30 %ile	26	5.1	6.6	6.4	5.2	6.1	6.3	5.8	6.0	4.5	7.2
50 %ile	28	5.1	6.6	6.4	5.0	6.1	6.4	5.8	5.9	5.9	6.1
98 %ile	19	5.1	6.1	6.6	5.3	5.8	6.3	6.1	6.3	6.0	5.7
Shift	22	5.1	6.6	6.3	5.1	6.4	6.3	5.8	5.9	6.1	5.6
/r/	25	5.2	6.8	6.0	5.1	6.5	5.8	6.0	6.2	5.8	6.1
/l/	17	5.7	6.6	6.3	5.2	6.0	6.2	5.8	6.2	5.7	6.1
/s/	23	5.3	6.3	6.8	4.8	6.1	6.3	6.0	6.0	5.9	6.2
GIRLS Sample											
7 %ile	26	5.3	6.3	6.6	5.3	5.3	6.7	6.2	5.7	6.1	6.0
15 %ile	25	5.0	6.7	5.5	5.3	5.7	6.6	5.9	5.9	5.9	6.0
30 %ile	24	5.2	6.4	6.5	5.0	6.1	6.3	5.9	5.8	6.1	5.4
50 %ile	33	5.4	6.2	6.5	5.3	6.3	6.1	6.0	6.0	5.9	5.9
98 %ile	28	5.4	6.1	6.5	5.3	6.0	6.0	6.2	5.9	5.9	5.7
Shift	28	5.3	6.4	6.6	5.1	6.3	5.9	5.9	6.1	5.7	5.8
/r/	24	5.4	6.1	6.5	5.2	6.0	6.2	6.1	5.9	5.8	5.9
/l/	--	---	---	---	---	---	---	---	---	---	---
/s/	25	5.0	6.7	6.1	5.4	6.2	6.2	5.8	6.1	5.9	6.0

Table A-3. Intelligence Measures: WISC; Draw-a-Man Test; Ammons Full-Range Picture Vocabulary Test; Porteus Mazes. Means and Standard Deviations for Boys and Girls by Samples.

		WISC Session 9						Draw-a-Man Session 5		Ammons Session 3		Porteus Session 11	
		Verbal		Performance		Full Scale							
BOYS	N	X̄	SD	X̄	SD	X̄	SD	X̄	SD	X̄	SD	X̄	SD
Sample													
7 %ile	27	93.93	13.55	97.44	14.26	95.15	14.09	92.89	9.64	107.59	13.62	108.96	17.17
15 %ile	26	97.77	14.08	106.42	16.57	101.92	15.71	95.92	13.55	110.19	15.87	114.65	15.67
30 %ile	26	100.61	13.09	107.96	13.49	104.77	12.01	101.88	15.67	116.00	15.44	122.31	12.44
50 %ile	38	99.89	13.35	103.16	11.60	101.63	12.04	103.47	15.03	114.39	15.68	119.84	12.98
98 %ile	19	112.11	13.09	110.79	12.93	112.58	12.73	100.63	14.27	117.00	15.25	112.26	17.43
Shift	22	100.27	13.11	105.64	13.52	103.32	13.10	100.00	12.63	116.00	13.53	120.27	12.07
/r/	25	106.76	14.23	107.60	12.51	107.96	12.72	101.00	15.43	117.44	18.38	111.44	15.72
/l/	17	102.53	11.87	104.53	13.09	103.65	12.17	99.41	13.25	117.59	11.95	119.18	12.78
/s/	23	102.26	10.66	108.65	16.23	105.87	13.13	102.57	17.56	109.43	20.01	116.91	15.32
GIRLS													
Sample													
7 %ile	26	92.35	11.60	96.27	10.35	93.85	10.67	99.58	14.20	103.81	15.04	103.38	20.23
15 %ile	25	98.28	11.66	102.72	11.37	100.44	11.04	102.12	14.83	105.64	11.64	111.20	17.07
30 %ile	24	99.83	13.88	104.50	12.69	102.33	13.21	99.42	14.43	108.21	22.23	118.04	14.79
50 %ile	33	98.70	10.74	105.73	11.54	102.33	10.64	98.73	9.79	110.33	14.37	118.52	18.30
98 %ile	28	108.29	11.52	112.32	10.83	111.11	10.24	106.61	9.29	117.03	15.23	122.96	9.04
Shift	28	95.79	17.15	104.36	14.43	99.82	16.17	95.64	12.24	105.82	13.16	114.00	18.16
/r/	24	102.54	11.88	112.75	13.38	108.04	12.45	107.08	14.46	113.67	16.73	120.42	14.80
/l/	--	----	---	----	---	----	---	----	---	----	---	----	---
/s/	25	100.88	13.67	107.88	14.07	104.60	13.74	103.46	14.35	118.20	18.35	119.16	16.91

Table A-4. Articulation Measures: Prekindergarten Imitation Test; Total Score (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 1		Session 2		Session 3		Session 4		Session 5		Session 6	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Sample													
7 %ile	27	17.85	6.36	16.70	3.96	18.96	5.95	20.85	6.91	24.85	8.14	29.33	8.56
15 %ile	25	25.23	6.28	26.96	1.56	28.38	4.01	29.11	4.77	34.81	6.00	34.54	6.07
30 %ile	26	31.23	5.36	33.65	1.36	33.69	4.65	35.15	4.62	38.04	4.56	40.85	4.14
50 %ile	38	37.05	5.14	40.00	1.96	39.50	4.29	40.55	3.97	42.42	3.17	43.21	3.09
98 %ile	19	45.79	.41	46.00	0	44.05	1.79	42.31	3.93	43.63	1.93	44.37	2.50
Shift	22	28.18	9.06	31.73	10.10	31.95	9.93	33.27	8.69	36.41	6.83	37.82	7.68
/r/	25	34.52	5.77	37.64	3.22	36.36	4.05	35.80	4.19	40.84	2.96	42.56	2.28
/l/	17	36.53	4.90	35.76	3.80	38.41	5.03	39.29	4.90	41.65	3.60	41.71	3.78
/s/	23	34.09	4.84	35.57	3.36	34.48	5.06	35.39	4.94	37.65	5.77	39.26	5.08
GIRLS													
Sample													
7 %ile	26	21.19	7.05	21.27	3.77	24.54	6.03	27.50	6.49	33.96	6.37	37.31	6.18
15 %ile	25	31.04	5.86	31.16	1.74	33.20	4.21	35.44	5.73	37.92	5.04	38.60	5.06
30 %ile	24	36.87	4.22	37.92	1.47	37.96	3.37	39.13	4.30	41.13	3.50	41.71	4.14
50 %ile	33	40.76	4.23	43.24	.70	41.94	3.16	42.12	3.64	43.30	2.50	44.18	1.98
98 %ile	28	45.68	.89	45.96	.18	43.93	1.87	41.75	3.42	44.64	1.84	44.21	2.65
Shift	28.	32.25	9.20	35.78	9.03	36.43	6.29	36.03	6.73	38.75	5.69	40.86	5.40
/r/	24	35.21	5.84	38.42	2.87	37.92	4.50	38.13	4.50	41.29	3.76	42.75	2.76
/l/	----	----	---	----	---	----	---	----	---	----	---	----	---
/s/	25	35.36	4.52	36.04	3.46	35.44	4.36	37.28	5.17	37.92	5.09	38.76	5.23

Table A-4. Articulation Measures: Prekindergarten Imitation Test; Total Score (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session. (Cont.)

		Session 7		Session 8		Session 9		Session 10		Session 11	
BOYS	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Sample											
7 %ile	27	31.63	8.73	33.37	8.81	37.04	7.69	36.55	8.43	38.00	9.01
15 %ile	26	37.85	5.04	37.88	5.74	40.50	4.62	40.00	4.75	41.35	4.72
30 %ile	26	40.50	5.40	41.00	3.70	42.35	3.38	42.31	3.24	43.31	3.39
50 %ile	38	44.21	1.91	42.89	2.86	44.47	1.77	44.18	1.89	43.74	3.25
98 %ile	19	44.68	1.75	44.89	1.55	45.05	1.36	44.21	2.26	44.47	2.23
Shift	22	39.59	4.99	40.64	5.87	42.18	5.26	41.32	4.41	41.73	4.34
/r/	25	42.64	2.15	41.12	4.34	42.96	3.63	43.24	3.06	44.12	3.17
/l/	17	44.00	2.06	43.53	2.97	44.71	2.24	45.00	1.24	44.94	1.92
/s/	23	41.57	4.29	40.69	4.67	41.52	3.82	41.30	4.48	42.09	3.49
GIRLS											
Sample											
7 %ile	26	37.65	6.35	38.65	5.12	42.31	4.80	40.15	4.83	40.92	5.53
15 %ile	25	38.96	4.01	39.48	4.61	42.16	4.20	41.32	4.05	42.12	3.83
30 %ile	24	42.67	3.05	43.17	2.85	43.46	3.09	43.96	1.77	44.25	1.98
50 %ile	33	44.57	1.81	43.57	2.53	44.61	1.97	44.30	2.42	44.61	2.14
98 %ile	28	44.57	1.56	44.39	1.80	44.86	1.48	44.57	1.63	44.93	1.79
Shift	28	41.39	4.97	41.03	4.36	42.75	3.32	42.71	3.05	43.57	3.05
/r/	24	43.29	1.79	43.38	2.45	44.33	2.54	44.29	1.54	44.88	2.11
/l/	--	----	---	----	---	----	---	----	---	----	---
/s/	25	39.84	4.58	39.76	4.84	41.64	4.42	41.52	4.22	41.72	4.66

Table A-5. Articulation Measures: Prekindergarten Imitation Test; Initial Consonants (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 1		Session 2		Session 3		Session 4		Session 5		Session 6	
	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
BOYS													
Sample													
7 %ile	27	4.96	2.22	4.93	1.63	5.48	2.22	6.70	2.79	7.41	2.68	8.63	2.74
15 %ile	26	6.69	1.99	7.46	1.18	7.81	1.33	8.38	1.82	10.27	2.10	10.04	1.85
30 %ile	26	8.50	2.04	9.42	1.08	9.69	1.83	10.42	1.55	11.27	1.35	11.61	1.44
50 %ile	38	10.00	1.79	10.84	1.41	11.26	1.41	11.76	1.27	12.05	1.15	12.31	1.05
98 %ile	19	12.84	.36	13.00	0	12.42	.81	12.58	.75	12.58	.59	12.68	.80
Shift	22	7.36	2.98	8.73	3.40	9.14	3.35	9.77	2.80	10.68	2.01	11.05	2.05
/r/	25	9.88	1.97	10.72	1.46	11.12	1.21	11.44	1.02	12.04	.82	12.44	.64
/l/	17	9.59	2.09	9.94	1.86	11.00	1.71	15.00	1.41	12.35	.68	12.06	1.00
/s/	23	9.69	1.60	10.09	1.35	9.87	1.78	10.65	1.90	11.00	1.82	11.13	1.87
GIRLS													
Sample													
7 %ile	26	6.19	2.40	6.35	1.64	7.23	2.22	8.73	1.99	10.11	1.89	11.04	1.76
15 %ile	25	8.40	2.08	8.84	1.05	9.72	1.28	10.40	1.67	10.68	1.62	10.96	1.61
30 %ile	24	10.08	1.68	10.54	1.04	11.08	1.19	11.79	1.00	12.00	1.29	12.08	1.25
50 %ile	33	11.21	1.65	12.03	.72	12.00	1.07	12.27	.75	12.33	8.04	12.55	.61
98 %ile	28	12.93	.26	13.00	0	12.79	.41	12.46	.87	12.79	.41	12.68	.66
Shift	28	8.89	2.50	10.21	2.82	10.18	2.36	10.79	2.45	11.43	1.78	11.71	1.73
/r/	24	9.67	1.77	10.92	1.15	10.96	1.51	11.67	.90	12.17	.99	12.46	.71
/l/	--	----	---	----	---	----	---	----	---	----	---	----	---
/s/	25	9.92	1.76	10.32	1.54	10.40	1.26	11.20	1.47	10.88	1.56	11.16	1.62

Table A-5. Articulation Measures: Prekindergarten Imitation Test; Initial Consonants (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session. (Cont.)

		Session 7		Session 8		Session 9		Session 10		Session 11	
BOYS	N	X̄	SD	X̄	SD	X̄	SD	X̄	SD	X̄	SD
Sample											
7 %ile	27	9.78	2.53	10.11	2.77	10.67	2.61	10.93	2.29	11.44	2.17
15 %ile	26	10.81	1.84	11.23	1.78	11.85	1.38	11.69	1.23	12.00	1.27
30 %ile	26	11.92	1.27	11.92	1.14	12.42	.93	12.31	1.03	12.54	.84
50 %ile	38	12.71	.56	12.63	.67	12.84	.36	12.87	.34	12.50	.99
98 %ile	19	12.74	.44	12.89	.31	12.95	.22	12.84	.36	12.84	.49
Shift	22	11.82	1.23	12.00	1.17	12.36	1.11	12.41	.98	12.36	.98
/r/	25	12.48	.57	12.36	.89	12.40	.80	12.60	.75	12.76	.43
/l/	17	12.71	.57	12.76	.42	12.82	.38	13.00	0	12.82	.51
/s/	23	12.57	2.22	11.83	1.43	12.09	1.44	12.57	.77	12.17	1.01
GIRLS											
Sample											
7 %ile	26	11.19	1.75	11.81	1.47	12.19	1.30	11.88	1.67	12.38	1.04
15 %ile	25	11.32	1.29	11.80	1.23	12.28	1.11	11.96	1.15	12.16	.92
30 %ile	24	12.37	.81	12.63	.75	12.63	.56	12.87	.33	12.67	.62
50 %ile	33	12.76	.49	12.73	.51	12.88	.33	12.73	.62	12.85	.43
98 %ile	28	12.79	.49	12.82	.47	13.00	0	12.93	.26	12.54	.98
Shift	28	12.11	1.35	12.29	1.10	12.53	1.05	12.57	.68	12.78	.41
/r/	24	12.54	.71	12.58	.64	12.91	.28	12.58	.86	12.79	.50
/l/	--	----	---	----	---	----	---	----	---	----	---
/s/	25	11.40	1.70	11.28	1.56	12.08	1.16	11.88	1.53	11.92	1.32

Table A-6. Articulation Measures: Prekindergarten Imitation Test; Final Consonants. Means and Standard Deviations by Boys and Girls by Sample and Session.

		Session 1		Session 2		Session 3		Session 4		Session 5		Session 6	
	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
BOYS													
Sample													
7 %ile	27	10.63	3.53	9.67	2.37	9.89	2.92	9.96	2.74	12.59	3.58	14.26	3.89
15 %ile	26	13.92	2.45	14.61	1.98	14.92	2.74	14.08	2.97	16.85	2.61	16.46	2.63
30 %ile	26	16.58	2.26	17.23	1.45	16.50	1.87	16.27	2.52	17.54	2.21	18.77	1.55
50 %ile	38	17.66	2.38	18.31	1.28	17.79	2.09	17.97	2.35	19.34	1.53	19.71	1.71
98 %ile	19	21.00	0	21.00	0	20.05	1.00	18.11	3.37	19.42	1.46	19.95	1.47
Shift	22	14.95	3.69	15.82	3.95	15.36	3.97	15.36	3.14	17.05	2.91	17.59	3.31
/r/	25	17.44	1.86	18.44	1.55	16.84	2.54	15.96	2.73	19.24	1.07	20.00	.81
/l/	17	18.53	1.85	18.00	2.38	17.65	2.91	16.12	4.80	18.41	2.25	18.76	2.13
/s/	23	16.74	2.31	17.35	1.85	16.52	2.79	15.65	2.55	17.13	2.95	18.26	1.92
GIRLS													
Sample													
7 %ile	26	11.92	3.61	12.04	1.93	12.85	2.78	13.00	3.01	16.42	2.73	17.77	2.73
15 %ile	25	15.68	2.51	15.92	1.55	16.08	2.24	16.28	2.75	17.88	2.05	17.96	2.18
30 %ile	24	18.21	1.91	17.83	1.34	17.04	2.09	16.63	3.00	18.71	1.51	19.33	1.79
50 %ile	33	18.91	2.05	19.61	.69	18.42	2.59	18.39	2.74	19.45	1.69	20.15	1.05
98 %ile	28	20.82	.54	20.96	.19	19.43	1.50	17.79	2.73	19.61	2.32	20.00	.34
Shift	28	16.21	3.67	17.32	3.16	16.57	2.69	15.75	3.26	17.71	2.67	18.53	2.46
/r/	24	17.46	2.53	18.71	1.24	17.54	2.77	16.83	3.20	19.08	2.04	19.50	1.26
/l/	--	----	---	----	---	----	---	----	---	----	---	----	---
/s/	25	17.52	1.96	17.96	1.93	16.40	2.88	17.28	2.68	17.76	2.14	18.36	2.11

Table A-6. Articulation Measures: Prekindergarten Imitation Test; Final Consonants. Means and Standard Deviations by Boys and Girls by Sample and Session. (Cont.)

		Session 7		Session 8		Session 9		Session 10		Session 11	
	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
BOYS											
Sample											
7 %ile	27	14.63	4.15	16.30	3.64	17.93	3.27	17.59	3.58	18.59	3.30
15 %ile	26	17.77	2.17	18.15	2.58	18.96	2.08	18.46	2.31	19.38	1.60
30 %ile	26	18.61	2.34	18.96	2.01	19.65	1.38	19.65	1.41	19.73	1.65
50 %ile	38	19.84	1.58	19.87	1.61	20.61	.63	20.13	1.42	20.39	.99
98 %ile	19	20.31	2.15	20.74	.55	20.84	.36	20.16	1.39	20.21	1.28
Shift	22	18.95	2.05	19.55	1.90	19.77	1.95	19.18	2.10	19.36	1.82
/r/	25	19.32	1.76	19.76	1.33	20.28	1.15	20.16	1.25	20.20	.98
/l/	17	20.00	1.14	20.35	.90	20.39	1.07	20.47	1.14	20.53	1.33
/s/	23	19.13	3.34	18.78	1.86	19.48	1.61	19.43	1.17	19.70	1.33
GIRLS											
Sample											
7 %ile	26	17.69	2.93	18.04	2.59	19.42	1.88	18.69	2.27	19.19	1.82
15 %ile	25	18.28	1.40	19.12	1.42	19.84	1.29	19.72	1.46	19.68	1.76
30 %ile	24	19.58	1.32	20.17	1.62	20.54	.76	20.37	.99	20.25	1.16
50 %ile	33	20.06	1.35	19.61	1.77	20.57	1.05	20.15	1.08	20.42	1.21
98 %ile	28	20.03	1.05	20.00	1.48	20.32	1.07	20.50	1.02	20.11	1.40
Shift	28	18.71	2.33	19.04	2.06	19.43	1.72	20.00	1.19	20.04	1.02
/r/	24	19.50	1.22	20.00	1.32	20.46	.81	20.37	.86	20.54	1.04
/l/	--	----	---	----	---	----	---	----	---	----	---
/s/	25	18.60	1.83	18.64	2.35	19.72	1.59	19.60	1.79	19.32	1.67

Table A-7. Articulation Measures: Prekindergarten Imitation Test; Total Consonants (Minus /hw/). Means and Standard Deviations by Boys and Girls by Sample and Session. (Cont.)

		Session 7		Session 8		Session 9		Session 10		Session 11	
	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
BOYS											
Sample											
7 %ile	27	24.41	6.33	26.41	6.12	28.59	5.72	28.52	5.65	30.04	5.22
15 %ile	26	28.58	3.59	29.35	4.20	30.81	3.29	30.15	3.22	31.38	2.62
30 %ile	26	30.54	3.48	30.88	2.68	32.08	1.94	31.96	2.16	32.27	2.01
50 %ile	38	32.55	1.82	32.50	1.82	33.45	.78	33.00	1.54	32.89	1.71
98 %ile	19	32.74	1.74	33.63	.67	33.79	.41	33.00	1.55	33.05	1.70
Shift	22	30.78	3.06	31.55	2.84	32.14	2.94	31.59	2.59	31.73	2.56
/r/	25	32.16	1.15	32.12	2.07	32.68	1.85	32.76	1.79	32.96	1.18
/l/	17	32.71	1.36	33.12	1.23	33.12	1.18	33.47	1.14	33.35	1.75
/s/	23	31.26	2.23	30.61	3.09	31.57	2.75	32.00	1.77	31.87	2.25
GIRLS											
Sample											
7 %ile	26	28.88	4.27	29.85	3.72	31.61	3.03	30.58	3.54	31.58	2.66
15 %ile	25	29.60	2.26	30.92	2.37	32.12	2.20	31.68	2.31	31.96	2.14
30 %ile	24	31.96	1.72	32.79	2.25	33.17	1.18	33.25	1.01	32.92	1.52
50 %ile	33	32.82	1.59	32.33	2.13	33.45	1.13	32.88	1.53	33.27	1.48
98 %ile	28	32.82	1.35	32.82	1.58	33.32	1.07	33.43	1.01	32.57	2.14
Shift	28	30.82	3.41	31.32	2.88	31.96	2.54	32.61	1.63	32.82	1.26
/r/	24	32.04	1.54	32.54	1.66	33.37	.86	32.96	1.34	33.33	1.14
/l/	--	----	---	----	---	----	---	----	---	----	---
/s/	25	29.92	3.38	29.92	3.76	31.80	2.56	31.48	3.10	31.24	2.90

Table A-7. Articulation Measures: Prekindergarten Imitation Test; Total Consonants (Minus /hw/). Means and Standard Deviations by Boys and Girls by Sample and Session.

		Session 1		Session 2		Session 3		Session 4		Session 5		Session 6	
BOYS	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Sample													
7 %ile	27	15.59	5.15	14.59	2.87	15.37	4.08	16.66	5.04	20.00	5.82	22.89	6.11
15 %ile	26	20.61	3.86	22.08	2.23	22.73	3.41	22.46	4.10	27.11	4.33	26.50	4.37
30 %ile	26	25.08	3.69	26.65	1.82	26.19	3.08	26.69	3.39	28.81	3.19	30.38	2.69
50 %ile	38	27.66	3.71	29.16	2.08	29.05	3.11	29.74	3.11	31.39	2.31	32.03	2.44
98 %ile	19	33.84	.36	34.00	0	32.47	1.60	30.68	3.92	32.00	1.78	32.63	2.08
Shift	22	22.32	6.32	24.55	7.21	24.50	6.82	25.14	5.72	27.73	4.60	28.64	5.19
/r/	25	27.32	3.59	29.16	2.75	27.96	3.24	27.40	3.44	31.28	1.54	32.44	1.06
/l/	17	28.12	3.43	27.94	3.81	28.65	4.11	28.18	4.26	30.76	2.69	30.82	2.83
/s/	23	26.43	3.70	27.43	2.92	26.39	4.15	26.30	3.84	28.13	4.45	29.39	3.50
GIRLS													
Sample													
7 %ile	26	18.11	5.41	18.38	2.63	20.08	4.30	21.73	4.40	26.54	4.14	28.81	3.93
15 %ile	25	24.08	4.16	24.76	2.06	25.80	3.12	26.68	3.77	28.56	3.32	28.92	3.49
30 %ile	24	28.29	2.44	28.37	1.65	28.13	2.82	28.42	3.65	30.71	2.26	31.42	2.64
50 %ile	33	30.12	3.24	31.64	.64	30.70	3.00	30.70	3.24	31.79	2.20	32.70	1.45
98 %ile	28	33.75	.63	33.96	.19	32.21	1.65	30.07	3.44	32.75	1.86	32.68	1.75
Shift	28	25.11	5.66	27.50	5.76	26.79	4.80	26.53	4.91	29.14	4.00	30.25	3.88
/r/	24	27.13	3.94	29.63	2.19	28.50	3.94	28.50	3.76	31.25	2.59	31.96	1.74
/l/	--	----	---	----	----	----	---	----	---	----	---	----	---
/s/	25	27.44	3.42	28.28	3.28	26.80	3.70	28.48	3.92	28.64	3.51	29.56	3.51

Table A-8. Articulation Measures: Kindergarten Imitation Test; Total Score (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 3		Session 4		Session 5		Session 6		Session 7	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Sample											
7 %ile	27	27.00	6.41	28.48	7.88	33.22	8.66	37.59	8.67	40.30	9.25
15 %ile	26	37.31	4.04	38.00	4.87	43.81	6.00	43.54	6.07	46.85	5.04
30 %ile	26	42.58	4.72	44.00	4.69	47.04	4.56	49.85	4.14	49.46	5.44
50 %ile	38	48.37	4.35	49.47	4.07	51.42	3.17	52.18	3.09	53.21	1.91
98 %ile	19	53.00	1.78	51.21	4.12	52.58	1.95	53.37	2.50	53.63	1.72
Shift	22	40.73	10.05	42.00	8.81	45.41	6.83	46.77	7.72	49.50	4.89
/r/	25	45.28	3.99	44.80	4.19	49.80	2.97	50.76	3.88	51.64	2.15
/l/	17	47.41	5.03	48.12	5.09	50.65	3.60	50.65	3.72	53.00	2.06
/s/	23	43.43	5.29	44.26	4.90	46.65	5.77	48.26	5.08	50.57	4.29
GIRLS											
Sample											
7 %ile	26	33.04	6.22	36.00	6.83	42.88	6.45	45.92	6.13	46.61	6.39
15 %ile	25	42.08	4.49	44.28	5.81	46.92	5.04	47.48	5.04	48.04	3.84
30 %ile	24	46.50	3.19	47.87	4.40	50.13	3.50	50.67	4.11	51.67	3.05
50 %ile	33	50.94	3.16	51.03	3.68	52.30	2.50	53.18	1.98	53.55	1.79
98 %ile	28	52.93	1.87	50.64	3.60	53.64	1.84	53.18	2.63	53.57	1.57
Shift	28	45.39	6.29	44.93	6.88	47.71	5.78	49.86	5.40	50.36	4.96
/r/	24	46.92	4.50	46.92	4.76	50.29	3.76	51.75	2.76	52.29	1.79
/l/	--	-----	----	-----	----	-----	----	-----	----	-----	----
/s/	25	44.28	4.23	46.16	5.36	46.92	5.09	47.76	5.23	48.88	4.63

Table A-8. Articulation Measures: Kindergarten Imitation Test; Total Score (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session. (Cont.)

		Session 8		Session 9		Session 10		Session 11	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Sample									
7 %ile	27	41.89	9.39	45.85	8.03	45.41	8.76	46.96	9.08
15 %ile	26	46.81	5.82	49.46	4.65	48.92	4.74	50.35	4.72
30 %ile	26	50.00	3.70	51.35	3.38	51.35	3.15	51.54	3.96
50 %ile	38	51.68	3.08	53.34	1.85	53.13	1.89	52.71	3.24
98 %ile	19	53.89	1.55	54.05	1.36	53.16	2.35	53.47	2.23
Shift	22	48.82	5.00	51.09	5.23	50.27	4.45	50.64	4.41
/r/	25	50.08	4.33	51.96	3.63	52.24	3.06	52.72	2.75
/l/	17	52.53	2.97	52.71	3.80	54.00	1.24	53.94	1.92
/s/	23	49.61	4.74	50.52	3.82	50.30	4.48	51.09	3.49
GIRLS									
Sample									
7 %ile	26	47.54	5.27	50.54	4.58	49.15	4.83	49.92	5.53
15 %ile	25	48.40	4.71	51.08	4.22	50.28	4.04	51.12	3.84
30 %ile	24	52.04	3.07	52.41	3.20	52.96	1.77	53.29	1.99
50 %ile	33	52.48	2.61	53.61	1.97	52.76	2.64	53.61	2.14
98 %ile	28	53.36	1.84	53.82	1.49	53.57	1.63	53.93	1.79
Shift	28	49.96	4.35	51.75	3.32	51.68	3.04	52.57	3.05
/r/	24	52.29	2.46	53.29	2.56	53.29	1.54	53.79	2.25
/l/	--	-----	----	----	---	----	---	----	---
/s/	25	48.72	4.81	50.56	4.52	50.52	4.22	50.68	4.75

Table A-9. Articulation Measures: Long Articulation Test; Blends. Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 3		Session 4		Session 5		Session 6		Session 7	
	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
BOYS											
Sample											
7 %ile	27	120.89	28.98	125.96	34.24	143.59	38.82	170.30	41.70	177.22	41.26
15 %ile	26	167.58	25.14	174.08	23.13	197.04	30.30	196.35	27.03	210.61	24.20
30 %ile	26	190.35	21.55	199.27	23.30	209.81	20.85	221.88	22.36	221.64	23.84
50 %ile	38	219.24	17.09	219.45	15.09	231.34	13.77	234.74	13.23	238.84	9.04
98 %ile	19	236.32	6.94	233.21	11.12	239.89	6.01	241.42	5.52	244.16	3.30
Shift	22	186.64	38.29	190.41	34.99	203.64	29.85	214.14	34.05	220.82	26.95
/r/	25	182.04	12.77	185.72	16.03	207.80	24.74	223.96	24.85	224.64	19.64
/l/	17	212.41	16.27	216.82	16.08	226.47	15.29	230.76	15.62	239.00	11.21
/s/	23	200.26	19.19	202.96	17.41	213.83	18.09	221.87	20.02	225.57	29.88
GIRLS											
Sample											
7 %ile	26	144.27	29.31	155.46	31.25	187.77	33.69	200.42	35.03	204.04	28.39
15 %ile	25	186.88	27.92	192.80	26.80	209.52	28.35	215.08	19.86	214.36	21.09
30 %ile	24	205.58	18.49	215.50	19.14	222.21	19.22	227.08	21.24	231.83	14.20
50 %ile	33	231.97	10.20	230.00	11.89	236.85	9.09	240.09	8.23	239.94	7.51
98 %ile	28	237.14	6.67	233.18	8.76	243.14	4.84	242.11	8.41	242.21	5.63
Shift	28	200.64	30.28	200.61	34.01	212.25	35.11	219.68	28.14	223.57	25.65
/r/	24	196.25	22.66	199.33	23.99	215.75	25.52	226.50	24.39	234.13	13.28
/l/	--	----	---	----	---	----	---	----	---	----	---
/s/	25	205.96	15.31	211.44	18.97	216.28	18.77	218.80	19.22	222.96	17.17

Table A-9. Articulation Measures: Long Articulation Test; Blends. Means and Standard Deviations for Boys and Girls by Sample and Session. (Cont.)

		Session 8		Session 9		Session 10		Session 11	
BOYS	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Sample									
7 %ile	27	190.70	45.19	208.96	37.69	208.30	43.69	212.41	40.97
15 %ile	26	215.88	28.95	226.50	27.70	225.54	23.64	232.69	18.10
30 %ile	26	229.00	18.41	234.46	17.06	234.50	14.68	235.46	14.70
50 %ile	38	234.03	36.57	244.37	4.68	242.84	7.55	240.55	9.41
98 %ile	19	246.95	1.57	247.95	9.56	242.68	6.38	244.37	5.11
Shift	22	226.41	23.50	233.91	20.94	232.14	16.30	233.41	17.79
/r/	25	225.52	24.14	233.80	19.05	235.16	23.20	235.72	17.73
/1/	17	240.82	9.94	245.00	4.26	244.47	4.13	244.29	6.54
/s/	23	228.39	16.82	232.00	16.13	233.57	16.96	234.22	16.01
GIRLS									
Sample									
7 %ile	26	214.73	29.82	229.35	24.73	223.04	24.53	226.92	25.79
15 %ile	25	223.96	20.62	231.36	19.33	229.04	16.23	230.56	15.45
30 %ile	24	239.79	9.26	239.29	14.31	241.79	6.01	239.75	11.71
50 %ile	33	240.64	9.66	244.91	4.83	242.51	6.63	243.48	7.16
98 %ile	28	243.39	5.21	245.46	3.60	245.03	7.84	244.82	3.89
Shift	28	229.11	23.55	235.29	14.94	233.43	17.78	238.07	11.82
/r/	24	237.54	13.18	241.75	7.63	242.50	6.93	242.50	11.31
/1/	--	----	---	----	----	----	---	----	---
/s/	25	223.72	18.52	233.36	16.13	231.56	17.24	230.56	17.08

Table A-10. Articulation Measures: Spencer Nonsense Test; Initial Consonants (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 3		Session 5		Session 6		Session 7	
	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
BOYS									
Sample									
7 %ile	27	15.07	3.64	16.89	3.17	17.26	3.54	18.37	3.51
15 %ile	26	18.23	2.10	20.46	2.06	19.65	2.72	20.85	2.25
30 %ile	26	19.88	1.55	21.19	1.52	21.54	1.52	21.69	1.61
50 %ile	38	21.55	1.48	22.21	1.19	22.34	.98	22.63	.74
98 %ile	19	22.74	.44	22.58	.81	22.74	.55	22.74	.55
Shift	22	19.50	3.92	20.59	2.37	20.64	2.23	21.68	1.87
/r/	25	21.08	1.60	22.12	.81	22.32	.55	22.96	2.13
/l/	17	20.82	1.82	22.00	.97	22.65	.68	22.71	.45
/s/	23	20.43	1.44	21.26	1.54	21.35	1.97	21.87	1.54
GIRLS									
Sample									
7 %ile	26	17.96	2.83	20.27	2.21	21.00	1.82	21.27	1.93
15 %ile	25	20.60	1.47	20.48	1.83	20.88	1.84	21.28	1.40
30 %ile	24	21.42	1.29	22.25	.83	22.13	1.05	22.46	.76
50 %ile	33	22.33	.84	22.33	.84	22.33	.80	22.76	.43
98 %ile	28	22.68	.54	22.79	.41	22.82	.38	22.64	.72
Shift	28	20.89	2.13	21.29	1.81	21.53	2.08	22.00	1.49
/r/	24	20.83	1.55	22.29	.84	22.46	.64	22.67	.55
/l/	--	-----	---	----	---	----	---	----	---
/s/	25	20.72	1.40	21.04	1.89	21.20	1.62	21.24	1.84

Table A-10. Articulation Measures: Spencer Nonsense Test; Initial Consonants (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session. (Cont.)

		Session 8		Session 9		Session 10		Session 11	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Sample									
7 %ile	27	19.15	3.65	20.26	3.15	20.37	3.39	21.00	2.79
15 %ile	26	20.61	2.17	21.73	1.65	21.54	1.78	21.81	1.73
30 %ile	26	21.73	1.35	22.31	1.17	22.15	1.06	22.35	1.00
50 %ile	38	22.74	.50	22.81	.45	22.76	.63	22.58	.85
98 %ile	19	22.95	.22	22.84	.36	22.53	.68	22.84	.36
Shift	22	21.77	1.38	22.23	1.31	22.36	.83	22.36	1.02
/r/	25	22.20	.98	22.52	.64	22.64	.69	22.60	.63
/l/	17	22.76	.42	22.88	.32	22.76	.42	22.59	.97
/s/	23	21.87	1.78	21.96	1.55	22.30	1.12	21.70	1.92
GIRLS									
Sample									
7 %ile	26	21.38	1.86	21.88	1.65	21.61	1.92	22.12	1.42
15 %ile	25	21.40	1.41	22.40	.85	21.84	1.22	22.28	1.04
30 %ile	24	22.50	.65	22.58	.70	22.67	.69	22.67	.74
50 %ile	33	22.57	.78	22.85	.43	22.67	.59	22.82	.52
98 %ile	28	22.71	.52	22.93	.26	22.93	.26	22.89	.41
Shift	28	22.14	1.38	22.25	1.12	22.32	1.00	22.54	.68
/r/	24	22.63	.63	22.71	.84	22.87	.33	22.79	.50
/l/	--	----	---	----	---	----	---	----	---
/s/	25	21.16	2.07	22.08	1.32	21.52	1.53	21.96	1.40

Table A- 11. Articulation Measures: Spencer Nonsense Test; Final Consonants. Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 3		Session 5		Session 6		Session 7	
BOYS	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Sample									
7 %ile	27	11.07	4.05	13.11	3.22	13.26	4.17	14.59	4.80
15 %ile	26	16.15	2.70	16.77	2.42	15.61	3.01	17.81	2.22
30 %ile	26	16.35	2.56	17.69	2.35	18.58	2.06	18.88	1.69
50 %ile	38	18.55	2.18	18.81	2.17	19.32	1.54	20.18	1.14
98 %ile	19	20.00	1.17	19.84	1.23	20.05	1.10	20.74	.44
Shift	22	16.00	4.10	17.55	3.17	18.05	3.34	18.91	2.63
/r/	25	18.24	2.03	18.88	1.92	19.20	1.70	20.12	.77
/l/	17	18.41	1.97	18.12	2.25	18.29	2.35	19.88	1.28
/s/	23	17.17	2.88	18.35	2.01	18.13	2.15	20.04	4.46
GIRLS									
Sample									
7 %ile	26	14.19	3.45	17.00	2.77	17.04	3.04	17.77	2.49
15 %ile	25	17.24	1.97	17.52	1.92	17.52	2.37	17.96	1.78
30 %ile	24	19.00	1.68	18.13	1.79	19.37	1.77	19.63	1.52
50 %ile	33	19.82	1.62	20.03	1.11	19.91	1.22	19.91	1.16
98 %ile	28	20.53	.91	20.36	.97	20.14	1.06	20.50	.63
Shift	28	17.71	3.22	17.82	2.52	18.11	2.92	18.64	2.52
/r/	24	18.25	2.18	19.42	1.35	19.54	1.38	20.00	.71
/l/	--	-----	---	----	---	----	---	----	---
/s/	25	18.24	1.75	18.32	2.11	18.92	1.81	18.80	1.98

Table A-11. Articulation Measures: Spencer Nonsense Test; Final Consonants. Means and Standard Deviations for Boys and Girls by Sample and Session. (Cont.)

	N	Session 8		Session 9		Session 10		Session 11	
		$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
BOYS									
Sample									
7 %ile	27	15.11	3.99	17.41	3.30	17.26	3.31	17.85	3.13
15 %ile	26	17.50	2.34	18.35	2.27	18.11	2.12	19.31	1.96
30 %ile	26	19.00	1.62	19.65	1.49	19.31	1.29	19.92	1.24
50 %ile	38	19.71	1.27	20.53	.91	20.21	1.26	19.95	1.47
98 %ile	19	20.58	.81	20.58	.93	20.47	.80	20.58	.67
Shift	22	18.55	2.74	19.50	1.64	18.64	2.08	19.32	1.66
/r/	25	19.68	1.32	20.24	.99	20.16	1.25	19.96	1.22
/1/	17	19.88	1.28	20.35	.84	20.18	1.10	20.35	.68
/s/	23	18.96	2.03	19.48	1.64	19.57	1.50	19.22	1.56
GIRLS									
Sample									
7 %ile	26	17.88	2.29	19.19	1.64	18.65	1.77	19.46	2.00
15 %ile	25	18.60	2.02	19.84	1.05	19.16	1.76	19.84	.97
30 %ile	24	19.50	1.61	20.04	1.17	20.25	1.13	20.00	1.08
50 %ile	33	19.79	1.34	20.48	.82	20.24	.89	20.39	.81
98 %ile	28	20.07	1.19	20.02	.72	20.64	.67	20.57	.86
Shift	28	18.79	2.19	19.89	1.32	19.43	1.80	19.61	1.18
/r/	24	19.79	1.41	20.21	.91	20.17	1.03	20.17	.94
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/s/	25	18.16	2.31	19.28	1.59	19.40	1.65	19.52	1.60

Table A-12. Articulation Measures: Spencer Nonsense Test; Total Consonants (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 3		Session 5		Session 6		Session 7	
BOYS	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD
Sample									
7 %ile	27	26.19	6.17	30.00	5.64	30.52	7.14	32.96	7.85
15 %ile	26	34.38	4.11	37.23	3.89	35.27	5.40	38.65	4.10
30 %ile	26	36.23	3.66	38.88	3.51	40.11	3.25	40.58	3.07
50 %ile	38	40.11	3.17	41.03	2.95	41.66	2.14	42.81	1.57
98 %ile	19	42.74	1.21	42.42	1.76	42.79	1.24	43.47	.82
Shift	22	35.50	7.55	38.14	5.23	38.68	5.29	40.59	4.40
/r/	25	39.32	3.23	41.00	2.24	41.52	1.81	42.68	1.05
/l/	17	39.23	3.47	40.12	2.63	40.94	2.77	42.59	1.65
/s/	23	37.61	3.84	39.61	3.24	39.48	3.88	39.57	7.82
GIRLS									
Sample									
7 %ile	26	32.15	6.02	37.27	4.51	38.04	4.37	39.04	4.08
15 %ile	25	37.84	2.99	38.00	3.39	38.40	3.87	39.24	2.66
30 %ile	24	40.42	2.43	40.37	2.19	41.50	2.69	42.08	2.06
50 %ile	33	41.55	3.95	42.36	1.67	42.24	1.69	42.67	1.43
98 %ile	28	43.21	1.23	43.14	1.16	42.96	1.27	43.14	1.06
Shift	28	38.61	5.05	39.11	4.12	39.64	4.71	40.64	3.65
/r/	24	39.08	3.25	41.71	1.77	42.00	1.63	42.67	.85
/l/	--	----	---	----	---	----	---	----	---
/s/	25	38.96	2.83	39.36	3.87	40.12	3.18	40.04	3.70

Table A-12. Articulation Measures: Spencer Nonsense Test; Total Consonants (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session.. (Cont.)

		Session 8		Session 9		Session 10		Session 11	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Sample									
7 %ile	27	34.26	2.18	37.67	6.22	37.67	6.45	38.85	5.74
15 %ile	26	38.11	4.12	40.08	3.64	39.65	3.52	41.11	3.54
30 %ile	26	40.73	2.82	41.96	2.39	41.46	1.99	42.27	2.10
50 %ile	38	42.45	1.46	43.34	1.28	42.97	1.75	42.53	2.05
98 %ile	19	43.53	.82	43.42	1.14	41.63	6.16	43.42	.82
Shift	22	40.32	3.90	41.73	2.75	41.00	2.66	41.68	2.36
/r/	25	41.88	2.07	42.76	1.45	42.80	1.81	42.56	1.55
/l/	17	42.65	1.57	43.23	1.06	42.94	1.26	42.94	1.26
/s/	23	40.83	3.67	41.43	3.00	41.87	2.38	40.91	2.90
GIRLS									
Sample									
7 %ile	26	39.27	3.61	41.08	3.01	40.27	3.55	41.58	3.26
15 %ile	25	40.00	3.15	42.24	1.77	41.00	2.77	42.12	1.68
30 %ile	24	42.00	2.06	42.63	1.77	42.92	1.50	42.67	1.52
50 %ile	33	43.36	1.59	42.73	3.44	42.91	1.24	43.21	1.25
98 %ile	28	42.79	1.26	43.53	.82	43.57	.68	43.46	.98
Shift	28	40.93	3.34	42.14	2.10	41.75	2.44	42.14	1.62
/r/	24	42.42	1.73	42.92	1.32	43.04	1.13	42.96	1.31
/l/	--								
/s/	25	39.28	4.21	41.36	2.67	40.92	2.97	41.48	2.89

Table A-13. Articulation Measures: Long Articulation Test; Total Score (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 3		Session 4		Session 5		Session 6		Session 7	
	N	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{X}$	SD	$\overline{XX}$	SD
BOYS											
Sample											
7 %ile	27	144.19	33.25	150.63	38.83	171.89	44.17	201.55	47.26	210.26	47.55
15 %ile	26	199.11	26.59	205.11	24.25	232.65	33.59	231.69	29.31	247.88	26.54
30 %ile	26	225.38	23.02	234.23	25.07	247.31	23.23	261.04	24.60	260.92	26.66
50 %ile	38	256.89	1.95	257.50	17.69	271.16	15.52	275.42	15.07	280.05	10.33
98 %ile	19	278.00	8.03	272.53	14.45	280.63	7.23	282.89	9.66	285.63	4.64
Shift	22	219.82	44.53	223.91	40.35	240.27	33.19	251.77	38.81	260.36	29.46
/r/	25	218.20	14.75	221.72	18.65	247.80	25.72	261.16	22.03	265.36	20.08
/l/	17	249.71	19.59	255.35	21.46	265.71	17.57	270.35	17.81	280.23	12.50
/s/	23	235.22	22.80	237.65	20.15	250.87	21.85	260.13	23.14	269.56	18.63
GIRLS											
Sample											
7 %ile	26	172.85	32.63	185.69	33.75	222.92	37.15	237.69	38.02	241.50	31.64
15 %ile	25	221.28	29.78	227.92	29.50	246.72	30.52	252.56	22.62	252.80	23.00
30 %ile	24	242.17	19.29	251.92	21.31	261.37	20.63	267.25	23.46	272.63	15.61
50 %ile	33	271.30	12.47	269.00	14.81	277.24	10.42	281.36	9.36	281.61	8.34
98 %ile	28	277.75	7.85	271.93	12.20	284.46	6.29	283.50	9.91	284.00	6.59
Shift	28	235.29	33.66	235.57	38.02	250.03	38.70	258.57	31.43	263.14	28.35
/r/	24	233.25	25.85	236.33	26.82	255.67	27.57	267.29	25.20	274.87	13.97
/l/	--	----	---	----	---	----	---	----	---	----	---
/s/	25	241.44	17.71	248.48	22.35	253.48	21.81	257.68	22.20	261.80	20.03

Table A-13. Articulation Measures: Long Articulation Test; Total Score (Minus /hw/). Means and Standard Deviations for Boys and Girls by Sample and Session. (Cont)

		Session 8		Session 9		Session 10		Session 11	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SDQ	$X\bar{X}$	SD
Sample									
7 %ile	27	225.85	51.09	246.19	43.36	239.30	49.29	250.93	46.19
15 %ile	26	254.35	32.12	266.04	30.26	264.42	25.95	272.96	20.34
30 %ile	26	268.61	20.14	275.23	18.99	275.35	16.14	276.46	16.56
50 %ile	38	280.50	12.81	286.71	5.20	284.68	8.46	282.37	10.87
98 %ile	19	289.53	2.23	288.63	2.83	284.58	7.82	286.37	6.56
Shift	22	266.86	25.96	274.91	23.33	282.68	51.91	273.86	19.74
/r/	25	266.52	25.80	275.24	19.96	273.40	2.24	277.68	18.82
/l/	17	282.76	11.25	286.88	5.40	286.82	5.02	286.59	8.24
/s/	23	267.91	19.31	272.48	18.41	270.74	18.42	271.52	17.02
GIRLS									
Sample									
7 %ile	26	253.15	32.98	269.35	27.38	262.04	27.69	267.12	27.78
15 %ile	25	263.64	23.04	272.44	21.68	269.56	18.25	271.20	17.21
30 %ile	24	281.33	10.83	280.79	15.03	283.63	6.90	281.50	12.66
50 %ile	33	281.91	11.32	287.15	5.88	284.21	7.94	285.58	8.46
98 %ile	28	285.14	16.64	287.71	4.41	284.61	11.53	286.46	5.76
Shift	28	269.10	26.01	276.03	16.86	274.75	19.22	279.82	12.88
/r/	24	278.96	14.32	284.13	8.25	284.21	8.27	284.75	12.02
/l/	--	----	---	----	---	----	---	----	---
/ /s/	25	262.68	21.59	274.28	18.28	271.96	19.93	270.64	19.56

Table A-14. Articulation Measures: Duplicated Repetition. Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 3							
		/r/		/l/		/s/		Total	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Sample									
7 %ile	27	42.59	14.16	33.70	15.05	33.85	11.00	110.15	29.70
15 %ile	26	33.73	16.63	21.08	14.24	23.31	15.15	78.11	24.89
30 %ile	26	31.81	17.48	19.31	15.29	20.08	14.78	71.04	25.54
50 %ile	38	12.97	9.49	11.68	6.39	9.66	8.23	34.31	16.77
98 %ile	19	8.31	.79	8.63	4.27	7.16	4.23	24.11	5.85
Shift	22	30.05	17.13	18.68=	13.69	17.68	13.92	66.41	36.07
/r/	25	45.88	13.17	11.48	7.67	8.00	5.34	65.36	16.23
/l/	17	13.41	7.28	22.53	14.25	7.18	2.06	43.12	18.05
/s/	23	11.00	4.48	9.87	5.79	28.82	14.95	49.65	18.02
GIRLS									
Sample									
7 %ile	26	41.08	15.33	24.69	14.48	28.92	12.62	94.69	25.13
15 %ile	25	26.08	19.08	13.12	7.37	26.64	14.84	65.84	27.54
30 %ile	24	22.75	17.13	11.63	6.32	9.17	5.56	43.54	23.45
50 %ile	33	9.48	2.61	8.27	3.81	8.33	6.76	26.09	8.83
98 %ile	28	8.07	.37	7.68	1.93	6.07	.37	21.82	2.28
Shift	28	25.07	18.72	13.79	11.10	14.39	11.99	53.25	29.91
/r/	24	39.42	18.64	7.71	1.49	8.13	14.87	55.25	18.79
/l/	--	-----	-----	-----	-----	-----	-----	------	-----
/s/	25	9.36	3.13	8.92	4.51	32.48	13.81	50.76	15.95

Table A-14 Articulation Measures: Duplicated Repetition. Means and Standard Deviations for Boys and Girls by Sample and Session. (Continued).

		Session 5							
		/r/		/l/		/s/		Total	
	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
BOYS									
Sample									
7 %ile	27	38.78	16.58	26.33	14.07	28.85	14.12	93.96	25.76
15 %ile	26	25.42	15.47	15.81	12.77	20.19	13.43	61.42	23.85
30 %ile	26	19.61	16.52	10.81	6.21	19.15	16.17	49.58	22.91
50 %ile	38	10.31	6.46	9.45	8.49	8.00	6.37	27.76	9.29
98 %ile	19	8.00	0	7.16	.67	7.53	6.01	22.68	6.01
Shift	22	21.64	17.08	11.36	8.14	12.32	10.46	42.59	25.86
/r/	25	35.92	19.37	8.44	4.17	6.36	1.23	50.72	2.03
/l/	17	10.18	4.89	14.12	8.87	7.76	3.89	32.06	10.03
/s/	23	9.48	3.81	9.69	5.40	23.48	16.46	42.65	17.61
GIRLS									
Sample									
7 %ile	26	30.61	18.90	18.54	13.34	17.50	14.81	66.65	31.86
15 %ile	25	18,52	17.31	10.88	6.48	22.56	15.57	51.96	27.07
30 %ile	24	16.33	15.52	8.71	3.22	6.58	1.66	31.63	16.03
50 %ile	33	9.00	2.41	8.00	3.31	8.36	7.18	25.36	8.23
98 %ile	28	8.32	1.31	7.43	1.08	7.89	6.57	23.64	6.56
Shift	28.	16.82	15.85	10.14	5.98	13.68	12.35	40.71	24.00
/r/	24	22.79	18.47	7.96	2.33	7.13	4.31	37.87	1.89
/l/	--	----	---	----	----	----	---	----	---
/s/	25	9.36	2.36	7.76	1.94	26.84	15.76	43.96	15.74

Table A-15. Articulation Measures: Phonemes in Sentences. Means and Standard Deviations for Boys and Girls by Sample and Session.

		Phonemes in Sentences: Session 11							
		/r/		/s/		/l/		Total	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Sample									
7 %ile	27	15.04	5.33	12.22	7.40	13.67	5.48	40.85	12.45
15 %ile	26	16.08	4.26	13.88	6.30	16.27	4.16	46.23	10.52
30 %ile	26	17.42	2.50	13.88	7.09	16.85	2.52	48.15	8.95
50 %ile	38	17.29	2.84	15.66	4.66	16.87	2.36	49.82	6.66
98 %ile	19	18.00	.00	17.79	.69	17.05	2.84	52.84	3.06
Shift	22	15.72	5.20	13.59	6.35	16.59	2.53	45.91	8.17
/r/	25	14.36	6.25	17.44	2.16	17.36	2.17	49.16	8.44
/l/	17	17.88	.32	17.82	.51	16.70	2.19	52.41	2.25
/s/	23	17.91	.28	13.04	6.34	16.91	2.57	47.87	6.52
GIRLS									
Sample									
7 %ile	26	15.81	5.21	15.46	5.77	16.69	2.45	47.96	8.66
15 %ile	25	17.24	2.44	14.48	6.05	17.04	2.01	48.76	6.84
30 %ile	24	17.25	3.60	16.54	3.96	17.58	1.61	51.38	5.30
50 %ile	33	17.94	.34	17.36	2.64	17.61	1.32	52.91	3.05
98 %ile	28	17.89	.41	17.75	.83	17.96	.18	53.61	1.05
Shift	28	16.82	3.38	16.36	4.44	17.61	1.50	50.78	5.33
/r/	24	17.54	1.50	17.62	.86	17.75	.83	52.92	3.01
/l/	--	-----	----	-----	----	-----	----	-----	----
/s/	25	17.32	2.13	10.76	8.08	17.40	1.85	45.48	9.60

Table A-16. Speech Measures: Intelligibility Ratings. Means and Standard Deviations for Boys and Girls by Sample and Session.

		Session 1		Session 2		Session 3		Session 4		Session 5		Session 6	
BOYS	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Sample													
7%ile	27	2.00	.61	2.07	.54	2.07	.47	1.93	.54	1.89	.50	1.78	.79
15%ile	26	1.58	.57	1.38	.56	1.46	.57	1.27	.52	1.31	.54	1.42	.69
30%ile	26	1.35	.47	1.35	.47	1.19	.48	1.04	.19	1.11	.32	1.15	.45
50%ile	38	1.13	.41	1.03	.16	1.05	.22	1.00	.00	1.00	.00	1.11	.31
98%ile	19	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.05	.22
Shift	22	1.55	.65	1.36	.71	1.27	.62	1.18	.39	1.09	.29	1.18	.39
/r/	25	1.16	.37	1.00	.00	1.00	.00	1.04	.19	1.00	.00	1.08	.27
/l/	17	1.23	.55	1.00	.00	1.06	.23	1.00	.00	1.00	.00	1.06	.23
/s/	23	1.30	.46	1.04	.20	1.13	.34	1.00	.00	1.04	.20	1.26	.61
GIRLS													
Sample													
7%ile	26	1.85	.77	1.58	.49	1.50	.57	1.31	.54	1.15	.36	1.38	.49
15%ile	25	1.20	.40	1.00	.00	1.12	.43	1.04	.19	1.00	.00	1.16	.46
30%ile	24	1.08	.28	1.00	.00	1.08	.28	1.00	.00	1.00	.00	1.13	.33
50%ile	33	1.03	.17	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00
98%ile	28	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00
Shift	28	1.18	.38	1.14	.44	1.21	.49	1.18	.47	1.14	.44	1.18	.47
/r/	24	1.17	.37	1.00	.00	1.08	.28	1.00	.00	1.00	.00	1.08	.28
/l/	--	----	---	----	---	----	---	----	---	----	---	----	---
/r/	25	1.08	.27	1.00	.00	1.04	.20	1.00	.00	1.00	.00	1.04	.20

Table A-16. Speech Measures: Intelligibility Ratings. Means and Standard Deviations for Boys and Girls by Sample and Session. (Cont.)

		Session 7		Session 8		Session 9		Session 10		Session 11	
	N	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
BOYS											
Sample											
7 %ile	27	1.52	.57	1.55	.63	1.44	.63	1.37	.48	1.33	.54
15 %ile	26	1.08	.27	1.08	.27	1.15	.45	1.08	.27	1.08	.27
30 %ile	26	1.00	.00	1.04	.20	1.04	.19	1.08	.27	1.04	.19
50 %ile	38	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00
98 %ile	19	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00
Shift	22	1.00	.00	1.00	.00	1.00	.00	1.09	.29	1.05	.21
/r/	25	1.00	.00	1.04	.19	1.00	.00	1.00	.00	1.00	.00
/l/	17	1.00	.00	1.00	.00	1.06	.23	1.00	.00	1.00	.00
/s/	23	1.00	.00	1.04	.20	1.00	.00	1.00	.00	1.00	.00
GIRLS											
Sample											
7 %ile	26	1.11	.32	1.11	.32	1.08	.27	1.15	.36	1.15	.45
15 %ile	25	1.04	.19	1.04	.19	1.00	.00	1.00	.00	1.04	.19
30 %ile	24	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00
50 %ile	33	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00
98 %ile	28	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00
Shift	28	1.03	.19	1.11	.31	1.14	.44	1.21	.49	1.14	.35
/r/	24	1.00	.00	1.00	.00	1.00	.00	1.04	.20	1.00	.00
/l/	--	----	---	----	---	----	---	----	---	----	---
/s/	25	1.00	.00	1.00	.00	1.00	.00	1.00	.00	1.00	.00

Table A- 17 Reading and Spelling Measures: Gates Reading Survey; Metropolitan Spelling Test. Means and Standard Deviations by Sample and Session.

		Gates Reading Survey								Metropolitan	
		Speed		Vocabulary		Comprehension		Total		Session 8	
BOYS	N	X	SD	X	SD	X	SD	X	SD	X	SD
Sample											
7 %ile	27	12.81	6.97	15.85	11.31	11.33	8.15	39.59	25.57	6.81	8.92
15 %ile	26	17.35	8.60	20.92	12.10	15.19	9.52	52.23	29.21	12.38	11.62
30 %ile	26	16.12	8.68	22.62	10.79	18.19	9.66	56.92	28.23	12.50	10.42
50 %ile	38	17.42	6.73	24.74	10.42	17.66	6.95	59.79	22.14	14.42	12.08
98 %ile	19	21.84	6.28	32.63	7.66	25.21	6.48	79.68	18.45	23.42	11.35
Shift	22	14.91	6.63	23.04	10.85	18.50	9.33	56.45	25.62	10.23	8.74
/r/	25	19.20	7.39	28.44	9.68	20.92	9.03	68.64	24.39	19.24	11.03
/l/	17	16.26	7.46	21.88	9.00	16.06	8.09	54.18	21.89	10.29	10.09
/s/	23	17.83	6.37	26.65	11.24	17.83	8.76	62.13	25.00	15.09	10.78
GIRLS											
Sample											
7 %ile	26	17.12	5.92	22.58	10.08	14.73	7.48	54.38	21.56	12.65	10.96
15 %ile	25	19.16	6.28	26.28	10.33	17.40	7.12	62.84	21.55	15.52	9.90
30 %ile	24	22.13	6.03	27.62	8.17	18.37	7.03	67.71	19.59	16.96	10.84
50 %ile	33	19.33	4.88	29.18	6.25	20.27	5.49	68.48	12.84	19.67	9.89
98 %ile	28	25.18	7.18	36.04	9.01	25.82	6.76	87.04	20.26	27.00	6.91
Shift	28	20.61	7.87	26.78	10.60	18.54	7.48	65.82	24.39	17.96	10.90
/r/	24	20.08	7.18	26.21	8.80	20.58	7.23	66.88	20.89	16.58	9.95
/l/	--	----	---	----	----	----	----	----	----	----	----
/s/	25	20.52	8.44	27.92	13.27	20.76	9.25	68.52	29.20	20.36	12.59

Table A-18. Correlations between Long Articulation Cluster Scores, Session 6, and Prekindergarten Total Scores at all Sessions, Boys and Girls.

	Sessions										
	1	2	3	4	5	6	7	8	9	10	11
BOYS											
Sample											
7 %ile	.58	.54	.61	.57	.66	.90	.82	.79	.64	.55	.58
15 %ile	.10	.31	.53	.39	.61	.73	.59	.60	.42	.55	.51
30 %ile	.14	.20	.32	.50	.50	.86	.65	.58	.36	.33	.41
50 %ile	.09	.37	-.08	-.09	.15	.84	.45	.32	.10	.30	.04
98 %ile	-.15	.06	-.56	-.01	.06	.42	.39	-.04	.00	.29	.18
Shift	.50	.53	.61	.61	.65	.95	.75	.69	.63	.24	.38
/r/	.13	.09	.33	.11	.41	.62	.48	.47	.31	.45	.50
/l/	.19	.45	.57	.49	.56	.81	.47	.30	.02	.28	.02
/s/	.29	.07	.57	.65	.63	.91	.56	.50	.48	.37	.30
GIRLS											
Sample											
7 %ile	.39	.01	.46	.55	.67	.90	.45	.63	.58	.19	.22
15 %ile	-.02	.07	.38	.45	.65	.87	.59	.45	.58	.39	.37
30 %ile	.07	.23	-.20	.22	.18	.91	.35	.42	.43	.32	.21
50 %ile	-.00	.00	.01	.02	.16	.83	.33	.00	.09	.19	-.09
98 %ile	.01	-.07	-.28	-.08	-.09	.94	.23	-.00	-.11	.36	.09
Shift	.35	.63	.75	.65	.82	.90	.80	.85	.70	.55	.75
/r/	.02	.23	.11	.12	.47	.79	.35	.24	.24	.17	.23
/l/	---	---	---	---	---	---	---	---	---	---	---
/s/	-.02	.39	.39	.60	.71	.93	.50	.54	.28	.63	.44

Table A-19. Correlations between Long Articulation Cluster Scores, Session 11, and Prekindergarten Total Scores at all Sessions, Boys and Girls.

	Sessions										
BOYS	1	2	3	4	5	6	7	8	9	10	11
Sample											
7 %ile	.18	.18	.31	.45	.57	.65	.75	.73	.85	.87	.97
15 %ile	.19	.11	.29	.35	.39	.46	.46	.51	.61	.69	.85
30 %ile	.05	.01	.42	.22	.30	.26	.44	.58	.73	.59	.68
50 %ile	-.07	-.25	-.24	-.08	.02	-.10	-.16	.39	.12	.35	.90
98 %ile	-.09	.00	.35	.24	-.02	-.11	.31	.40	.51	.54	.83
Shift	-.01	.06	.26	.27	.10	.22	.47	.53	.67	.24	.69
/r/	.17	-.07	.40	.27	.49	.57	.52	.52	.75	.72	.82
/l/	-.03	.05	.62	.31	.73	.50	.37	.70	.69	.76	.79
/s/	-.02	-.40	.11	.21	.32	.18	.18	.32	.27	.33	.61
GIRLS											
Sample											
7 %ile	-.17	-.29	.01	.23	.41	.13	.42	.46	.60	.68	.87
15 %ile	-.04	-.05	.43	.36	.55	.30	.48	.66	.43	.78	.86
30 %ile	.01	-.25	-.12	-.03	.23	.09	-.19	.41	.42	.35	.73
50 %ile	.11	.22	.30	.50	.07	.18	.18	.25	.33	.50	.96
98 %ile	-.22	-.16	.43	.08	.18	-.04	.05	.23	.25	.16	.76
Shift	-.07	.09	.33	.36	.48	.38	.57	.57	.61	.80	.85
/r/	.47	.17	.00	.44	-.20	.24	.14	.81	.86	.43	.89
/l/	---	---	---	---	---	---	---	---	---	---	---
/s/	-.06	.16	.19	.64	.25	.41	.38	.50	.65	.61	.92

Table A-20. Correlations between Long Articulation Cluster Scores, Session 6, and All Repeated Articulation Scores, Session 6, Boys and Girls.

	Tests								
	1.2 Total	1.2 IC	1.2 FC	1.2 TC	1.4 Total	1.5 Cluster	1.6 IC	1.6 FC	1.6 TC
BOYS									
Sample									
7 %ile	.90	.75	.80	.85	.91	1.00	.74	.70	.78
15 %ile	.73	.48	.47	.49	.73	1.00	.51	.62	.60
30 %ile	.86	.69	.77	.81	.86	1.00	.83	.61	.78
50 %ile	.84	.58	.61	.67	.83	1.00	.46	.80	.79
98 %ile	.42	.33	.35	.38	.42	1.00	-.31	.41	.23
Shift	.95	.83	.87	.88	.93	1.00	.77	.84	.85
/r/	.62	.30	.28	.39	.61	1.00	.30	.38	.44
/l/	.81	.63	.64	.71	.80	1.00	.51	.86	.85
/s/	.91	.81	.78	.86	.91	1.00	.68	.67	.72
GIRLS									
Sample									
7 %ile	.90	.48	.74	.73	.83	1.00	.50	.62	.64
15 %ile	.87	.75	.70	.78	.86	1.00	.67	.60	.68
30 %ile	.91	.81	.60	.79	.91	1.00	.75	.68	.74
50 %ile	.83	.47	.61	.66	.83	1.00	.34	.65	.63
98 %ile	.94	.82	.73	.87	.94	1.00	.38	.54	.57
Shift	.90	.76	.81	.85	.90	1.00	.83	.87	.91
/r/	.79	.31	.31	.36	.79	1.00	.23	.44	.46
/l/	---	---	---	---	---	----	---	---	---
/s/	.93	.78	.83	.85	.93	1.00	.35	.75	.79

Table A-21. Correlations between Long Articulation Cluster Scores, Session 11, and All Repeated Articulation Scores, Session 6, Boys and Girls.

	Tests								
	1.2 Total	1.2 IC	1.2 FC	1.2 TC	1.4 Total	1.5 Cluster	1.6 IC	1.6 FC	1.6 TC
BOYS									
Sample									
7 %ile	.97	.89	.92	.95	.97	1.00	.91	.90	.94
15 %ile	.85	.67	.83	.83	.85	1.00	.63	.65	.67
30 %ile	.68	.70	.66	.83	.87	1.00	.85	.75	.84
50 %ile	.90	.74	.62	.79	.90	1.00	.79	.59	.75
98 %ile	.83	.72	.86	.85	.83	1.00	.29	.52	.56
Shift	.69	.59	.62	.67	.68	1.00	.51	.69	.70
/r/	.82	.82	.61	.80	.91	1.00	.76	.23	.49
/l/	.79	.91	.72	.81	.79	1.00	.79	.25	.74
/s/	.61	.46	.41	.45	.61	1.00	.47	.44	.55
GIRLS									
Sample									
7 %ile	.87	.73	.67	.75	.87	1.00	.76	.87	.86
15 %ile	.86	.66	.57	.67	.85	1.00	.70	.55	.75
30 %ile	.73	.55	.45	.57	.74	1.00	.59	.38	.56
50 %ile	.96	.81	.65	.76	.96	1.00	.81	.82	.87
98 %ile	.76	.66	.82	.81	.76	1.00	.41	.52	.63
Shift	.85	.57	.71	.76	.85	1.00	.55	.37	.50
/r/	.89	.46	.43	.59	.85	1.00	.73	.66	.76
/l/	---	---	---	---	---	----	---	---	---
/s/	.92	.81	.76	.81	.92	1.00	.72	.59	.68

Table A-22. Correlations between Metropolitan Spelling Scores, Session 8, and Prekindergarten Total Scores at All Sessions, Boys and Girls.

	Sessions										
BOYS	1	2	3	4	5	6	7	8	9	10	11
Sample											
7 %ile	.34	.13	.09	.31	.43	.24	.43	.33	.35	.21	.26
15 %ile	.03	.06	.21	.22	.41	.08	-.17	.15	-.10	.00	.01
30 %ile	.49	.11	.13	.34	.26	-.09	-.20	-.29	-.32	-.16	.11
50 %ile	.28	.42	.06	.13	.14	.21	.34	.13	-.04	-.13	-.51
98 %ile	-.30	.00	.09	.19	.20	-.16	-.01	.13	.12	-.37	.04
Shift	.08	.09	-.03	.18	.13	.15	.00	.18	.09	-.28	.02
/r/	.41	.19	.03	-.25	.30	-.13	.17	-.26	-.41	-.25	-.04
/l/	.26	.19	.15	.15	.34	.29	.46	.18	.03	-.11	-.05
/s/	.21	-.01	.11	.03	-.04	-.12	-.01	-.31	.01	-.15	-.31
GIRLS											
Sample											
7 %ile	.08	-.18	.09	.11	.41	.30	.27	.33	.17	.03	.28
15 %ile	.16	-.23	.12	-.15	-.00	.24	.03	-.03	-.13	.28	.26
30 %ile	-.15	.16	-.27	.14	-.05	.10	.27	.06	.01	.39	.28
50 %ile	-.13	-.09	.04	.14	-.11	-.03	.13	-.17	.20	.40	.14
98 %ile	.38	-.36	-.23	-.07	-.13	.10	.08	-.48	.14	.32	.11
Shift	.34	.42	.31	.26	.55	.34	.31	.50	.25	.27	.25
/r/	-.03	.01	.06	.31	-.07	.33	.38	.09	.33	.41	.36
/l/	---	---	---	---	---	---	---	---	---	---	---
/s/	.36	.05	.16	.25	.04	-.05	-.11	.07	-.35	-.07	.02

Table A-23. Correlations between Gates Reading Total Scores, Session 11, and Prekindergarten Total Scores at All Sessions, Boys and Girls.

	Sessions										
BOYS	1	2	3	4	5	6	7	8	9	10	11
Sample											
7 %ile	.28	.25	.26	.31	.56	.49	.61	.61	.58	.58	.57
15 %ile	.03	.19	.09	.12	.36	.02	-.28	.09	-.23	-.03	.11
30 %ile	.22	-.11	.11	.04	.01	-.47	-.37	-.37	-.29	-.20	-.24
50 %ile	.31	.38	.01	.14	.09	.10	.15	.10	-.19	.07	-.35
98 %ile	-.25	.00	.25	.15	.33	-.34	-.09	.11	-.17	-.25	-.05
Shift	.18	.15	.01	.03	.05	-.06	.11	.24	.32	-.05	.33
/r/	.25	.24	-.08	-.27	.38	-.21	.01	-.14	-.48	-.24	-.09
/l/	.18	.43	.23	.47	.23	.44	.36	.10	-.33	-.11	-.21
/s/	.30	.07	.31	.08	.12	.06	.32	-.10	.16	-.03	-.20
GIRLS+											
Sample											
7 %ile	.01	.15	.11	-.00	.21	.20	.12	.11	.09	-.06	.22
15 %ile	.32	.05	.20	-.24	.12	.11	-.02	.14	.03	.27	.20
30 %ile	-.18	.20	-.52	-.00	-.04	.10	.15	.03	.07	.33	.14
50 %ile	-.02	-.24	.05	.17	-.24	-.30	.08	.03	.09	.35	.15
98 %ile	.27	-.35	-.11	-.22	.13	.18	.27	-.01	.34	.36	.07
Shift	.39	.40	.50	.42	.63	.48	.48	.66	.38	.44	.52
/r/	.11	.17	-.11	.21	-.05	.17	.32	.29	.44	.25	.41
/l/	---	---	---	---	---	---	---	---	---	---	---
/s/	.38	-.04	-.07	.15	-.07	-.23	-.21	-.05	-.28	-.28	.00

Table A-24. Correlations between Criterion Spelling Scores, Session 8, and All Repeated Articulation Scores at Session 8, Boys and Girls.

	1.2 Total	1.2 IC	1.2 FC	1.2 TC	1.4	1.5	1.6 IC	1.6 FC	1.6 TC
BOYS									
Sample									
7th %ile	.33	.36	.15	.25	.33	.25	.14	.39	.29
15th %ile	.15	.24	.32	.30	.15	.07	.23	.43	.37
30th %ile	-.29	-.24	-.37	-.38	-.29	-.39	-.01	.09	.05
50th %ile	.13	-.32	.09	-.03	.12	-.14	.01	.22	.20
98th %ile	.13	.24	.06	.16	.13	.14	.09	.08	.10
Shift	.18	.18	-.04	.05	.27	.21	.00	.31	.22
/r/	-.26	-.08	-.17	-.14	-.26	-.20	.18	.08	.13
/l/	.18	-.01	.01	.00	.18	.24	.26	.43	.42
/s/	-.31	-.34	-.34	-.36	-.31	-.17	-.36	-.20	-.28
GIRLS									
Sample									
7th %ile	.33	.22	.20	.23	.33	.23	.14	.32	.28
15th %ile	-.03	-.08	-.16	-.14	.04	-.01	.30	.29	.32
30th %ile	.06	.51	.21	.33	.09	.07	.21	.07	.12
50th %ile	-.17	-.19	-.01	-.06	-.17	-.19	-.22	.23	.08
98th %ile	-.48	-.40	-.35	-.45	-.49	-.48	.00	-.40	-.38
Shift	.50	.33	.26	.31	.51	.43	.37	.48	.46
/r/	.09	.11	-.30	-.20	.11	-.01	-.15	.01	-.05
/l/	---	---	---	---	---	---	---	---	---
/s/	.07	.15	-.01	.05	.06	-.05	.27	.33	.33

Table A-25. Correlations between Criterion Reading Scores, Session 11, and All Repeated Articulation Scores at Session 11, Boys and Girls.

	1.22 Total	1.2 IC	1.2 FC	1.2 TC	1.4	1.5	1.6 IC	1.6 FC	1.6 TC
BOYS									
Sample									
7th %ile	.57	.45	.55	.53	.57	.56	.50	.55	.55
15th %ile	.11	.09	-.09	-.01	.11	-.13	-.05	.09	.03
30th %ile	-.24	-.35	.37	.16	.08	-.04	-.07	.02	-.02
50th %ile	-.35	-.19	-.18	-.21	-.34	-.35	-.37	-.11	-.23
98th %ile	-.05	-.07	.00	-.02	-.05	-.02	-.18	.20	.08
Shift	.33	.27	.10	.18	.33	.17	.16	.11	.15
/r/	-.09	-.27	-.11	-.19	-.19	-.23	-.35	.28	.08
/l/	-.21	.05	-.11	-.07	-.21	-.14	-.19	.07	-.11
/s/	-.20	-.50	-.45	-.49	-.20	-.13	-.44	-.37	-.49
GIRLS									
Sample									
7th %ile	.22	.10	.14	.14	.22	.10	.09	.14	.13
15th %ile	.20	-.12	.32	.25	.20	.10	-.07	.28	.12
30th %ile	.14	.00	.42	.32	.13	.03	-.28	.35	.11
50th %ile	.15	.21	.05	.10	.15	.11	.22	.20	.22
98th %ile	.07	.12	.06	.14	.07	.11	.13	-.11	-.05
Shift	.52	.04	.52	.43	.52	.50	.29	.37	.39
/r/	.41	.38	.04	.21	.44	.47	.40	.40	.44
/l/	---	---	---	---	---	---	---	---	---
/s/	.00	-.11	-.04	-.07	.01	-.03	-.24	-.05	-.15

APPENDIX B: TESTS

1.1 Prekindergarten Picture Articulation Test*#

chair
leaf
flag
glass
train
bridge
smoke
window
roof
there
stove
smooth
slide
string
nose
thumb
teeth
zipper
vacuum cleaner
shovel
sandwich
cup
measure
tub
jack-in-the-box
fish
wheel
hat
yellow

1.2 Prekindergarten Imitation Articulation Test*

matches
knife
pin
teeth
car
bathtub
duck
fish
thumb
soap
shoe
valentine
there
chair
jacket
zipper
lamb
ring
watch
yellow
house
sled
dog
stove
smooth
bridge
wheel
smoke
train
bread
stairs
glass
flat
slide
string
measure
shovel

1.3 Kindergarten Picture Articulation Test*

chair
leaf
flag
glass
train
bridge
smoke
window
roof
there
stove
smooth
slide
string
nose
thumb
teeth
zipper
vacuum cleaner
shovel
sandwich
cup
measure
tub
jack-in-the-box
fish
hat
yellow
pencil
bell
dog
garage
wheel

* The phonemes evaluated are underlined in the test words.

# The words in 1.1 were used to evaluate the test sounds in 1.2 for Sessions 1 and 2.

1.4 Kindergarten Imitation Articulation Test*

matches
knife
pin
teeth
car
bathtub
duck
garage
fish
thumb
soap
shoe
valentine
there
chair
jacket
zipper
lamb
ring
watch
yellow
house
sled
dog
stove
smooth
bridge
wheel
smoke
train
bread
stairs
glass
flat
slide
string
measure
shovel

1.5 Phonemes in Consonant Clusters and /l/. /s/. /r/.*

matches
knife
pin
teeth
car
bathtub
duck
garage
fish
thumb
soap
shoe
valentine
there
chair
jacket
zipper
lamb
ring
watch
yellow
house
sled
dog
stove
smooth
bridge
wheel
arm
cups
presents
nails
smoke
color
planting
horn
boats
train
health
snowman
cold
hammer
clown
sharp
books
wolf
crayons
spoon
vacuum cleaner
blocks
heart
elephant
elephants
bread
stairs
hanger
glass
fork
stamps
drum
bulb
skate
zipper
flat
curb
o'possum
green
milk
sweeping
doctor
slide
card
wasp
frog
belt
swims
cracker
splash
iceberg
nest
three
help
stones
rubber
tunnel
scarf
mask
shredded wheat
sprinkle
rings
ladder
apple
fourth
sink
scratch
triangle
tubs
tiger
bottle
lamp
sleds
stopped
gopher
flower
buckle
horse
hand
locked
whisper
dogs
author
table
curve
caged
left
sister
gloves
washer
puddle
cars
twins
jumped
whisker
bathes
clover
eagle
porch
queen
sprinkle
December
feather
ruffle
large
dwarf
string
chasm
measure
whistle
girl
pitcher
shovel
square
first
month

* The phonemes evaluated are underlined in the test words.

Appendix B

1.6 Spencer Nonsense Word Articulation Test

zɛp
pouʃ
ðɔɪ
ræʒə
ʃað

budʒ
θɝ
læz
mitʃ
hɔb

nuf
tʃɔɪd
hwʊʒ
dɛv
dʒaɪk

weɪm
git
taʊg
jil
fɛs

kʌŋ
sɑn
voʊθ

1.7 Duplicated Repetition Articulation Test*

round
line
here
cloud
great

side
flat
free
spend
earn

pass
strong
walls
throw
nest

splash
other
feel
sweet
buckle

earth
bubble
play
snow
whisker
slow

1.8 and 3.11 Articulation in Sentences;* Homographs

1. A strange, round (ob'ject) was on the roof. (3 /r/)
2. Most schools do not (permit') sliding in the hall. (3 /s/)
3. A faithful friend will not (desert') his pals. (3 /l/)
4. The children will (present') their mother with a gift. (3 /r/)
5. His (con'duct) in school was satisfactory. (3 /s/)
6. A good lion tamer will not (subject') his animals to danger. (3 /l/)
7. The radio station will (record') the program. (3 /r/)
8. Sam finished his Boy Scout (proj'ect) last night. (3 /s/)
9. I like the (con'tent) of his last book. (2 /l/)
10. Does Mary (object') to doing her homework? (3 /r/)
11. My sister got her learner's (per'mit) on Saturday. (3 /s/)
12. The (des'ert) is very hot and dry. (2 /r/)
13. All eleven members of the club were (pres'ent). (3 /l/)
14. Be sure to (conduct') yourself properly at the meeting. (4 /r/)
15. History is an interesting (sub'ject) to study. (3 /s/)
16. Have you listened to the Beatles' latest (rec'ord)? (3 /l/)
17. Please (project') the picture on the screen so we can see it. (3 /s/)
18. The little baby seemed (content') as he fell asleep. (4 /l/)

* The phonemes evaluated are underlined.

2.3 Speech in Family Relations I

POSITIVE FEELINGS COMING FROM CHILD

1. N... (child's name) ... likes to ask you questions. Who does N... like to ask questions?
2. N... likes to tell you the stories she has learned at school. Who does N... like to tell stories to?
3. N... likes to tell important things to you better than anyone else in your family. Who does N... like to tell important things to?
4. When N... needs help, she/he likes to ask you. Who does N... ask when she/he needs help?
5. N... likes to tell you her/his secrets. To whom does N... like to tell her/his secrets?

NEGATIVE FEELINGS COMING FROM CHILD

6. N... doesn't like to tell you things because you get cross and tell N... to slow down and say things more carefully. Who tells N... to talk slower and say things more carefully?
7. N... doesn't like to tell you his/her secrets. Who doesn't N... like to tell his/her secrets to?
8. N... doesn't like to talk to you because you don't listen. Who doesn't listen to N...?
9. N... doesn't want to talk to you because you always tell N... to say things over. Who tells N... to say things over?
10. N... is afraid to tell you when he/she is hurt or in trouble. Who is N... afraid to tell about his/her troubles and hurts?

POSITIVE FEELINGS COMING TOWARDS CHILD

11. You like to play talking games with N.... Who likes to play talking games with N...?
12. You are never too busy to listen when N... asks you for help. Who is never too busy to listen when N... asks for help?
13. You help N... learn new words; how to say them and what they mean. Who likes to help N... learn new words?
14. You like to talk to N.... Who likes to talk to N...?
15. You like to listen to N.... Who likes to listen to N...?

NEGATIVE FEELINGS GOING TOWARDS THE CHILD

16. You get cross because you can't understand what N... says. Who gets cross when he/she can't understand what N... says?
17. You tell N... to talk more carefully. Who tells N... to talk more carefully?

2.3 Speech in Family Relations I, Cont.

18. You interrupt N... when he/she tries to tell you something. Who interrupts N... when he/she tells you something?
19. You think that N... talks too fast. Who thinks that N... talks too fast?
20. You answer for N... when someone asks N... a question. Who answers for N... when someone asks N... a question?

2.4 Speech in Family Relations II

POSITIVE FEELINGS COMING FROM CHILD

1. This person in the family likes to read to others.
2. This person in the family likes to talk on the telephone.
3. This person in the family likes to talk to children who visit in my home.
4. This person in the family likes to tell stories to other members of the family.
5. This person in the family sometimes plays word games or talking games with other family members.
6. This person in the family likes to talk.
7. This person in the family likes to tell about things he has done.
8. This person in the family likes to take a speaking part in programs.
9. This person in the family likes to be with people who speak very well.
10. This person in the family sometimes likes to talk like somebody like Huckleberry Hound or Red Skelton.
11. This person in the family can speak another language besides English.
12. This person in the family understands another language besides English.
13. This person in the family likes to watch television.
14. This person in the family likes to read to himself.
15. This person in the family likes to ask questions.

NEGATIVE FEELINGS COMING FROM CHILD

16. This person in the family doesn't like to answer the door.
17. This person in the family doesn't like to answer the telephone.
18. This person in the family doesn't like to talk to adults who visit at my home.
19. This person in the family doesn't like to sing and recite for other people.

2.4 Speech in Family Relations II, Cont.

20. This person in the family sometimes pronounces words wrong to attract attention.
21. This person in the family makes fun of the way other people talk.
22. This person in the family talks too fast.
23. This person in the family has difficulty making others understand him.

POSITIVE FEELINGS GOING TOWARDS CHILD

24. This person in the family likes to discuss things with me.
25. This person in the family likes to have me sing or recite for people.
26. This person in the family likes to read to me.
27. This person in the family sometimes plays word games or talking games with me.
28. This person in the family helps me learn how to say new words and tells me what they mean.
29. This person in the family listens when I talk to them.
30. This person in the family never interrupts me when I talk to them.
31. This person in the family takes me to see plays.
32. This person in the family suggests good books for me to read.
33. This person in the family helps me with difficult words when I am reading.

NEGATIVE FEELINGS GOING TOWARDS THE CHILD

34. This person in the family asks me to say things over and over.
35. This person in the family tells me to talk slower and say things more carefully.
36. This person in the family never helps me learn how to say new words or tells me what they mean.
37. This person in the family never listens when I talk to them.
38. This person in the family sometimes interrupts me when I talk.
39. This person in the family sometimes answers for me when someone asks me a question.
40. This person in the family sometimes makes fun of the way I talk.

3.2 Grade 1 Vocabulary Recognition (Based on first grade Scott Foreman Vocabulary)

laugh
soon
room
peep
blue
first
door
that
back
bird
in
doing
maybe
then
please
look
bump
very
pushed
barn
father

wish
what
hurry
cow
too
stop
night
little
our
on
time
after
let's
ask
ate
open
but
well
food
dear
your

apple
want
she
say
every
guess
up
cat
horse
has
rabbit
thing
called
eat
which
four
met
and
glad
must
jump

head
ride
nest
helped
along
yellow
take
so
bird
surprised
fell
of
sang
cookie
his
toy
good
began
pretty
cannot
why

work
pig
read
run
paint
man
thought
grandmother
dinner
lost
kitten
way
children
here
fast
moo
run
story
slow
bow-wow
nothing
get

3.3 Grade 2 Vocabulary Recognition (Based on second grade Scott Foreman Vocabulary)

almost
years
barked
quiet
yet
everybody
wings
weather
grunting
boxes
uncle
knew
noise
sorry
handkerchief
dig
better
keep
pay
second

station
forest
supper
resting
engine
given
wheat
great
cart
vines
line
care
by
hair
field
slide
kind
chimney
gone
straw

joke
nickels
sing
cool
tweet
past
bags
gobble
perhaps
river
forget
hurt
o'clock
silly
visit
clowns
cabbage
porridge
catch
pot

still
caps
carried
mouth
moving
wren
leafy
hear
hard
ago
honey
waved
shovel
suddenly
wait
Saturday
large
lion
place
boil

trip
bring
pins
maple
hardly
teaching
even
cream
meet
game
each
paper
gave
buzz
breakfast
ten
blew
riding
goose
men

4.3 Spelling Dictation: Words and Sentences

1.	sage	Sage makes turkey dressing tasty.
2.	fabric	Nylon is a synthetic fabric.
3.	employment	School dropouts do not find employment easily.
4.	trays	The waiters carried the food on trays.
5.	budge	When a car is stuck in a rut it is difficult to budge it.
6.	hemisphere	The United States is located in the Northern hemisphere.
7.	submerge	A careful skin diver will submerge slowly.
8.	moisten	A fine spray will just moisten the grass.
9.	ferries	Ferries carry people and cars across wide rivers.
10.	sponge	A sponge can be made of rubber or plastic.
11.	flake	Every flake of snow has a different design.
12.	bulge	Water will sometimes make a cellar wall bulge.
13.	spies	In wartime, generals use spies to learn about enemy activities.
14.	coil	The electric coil on the stove can get red hot.
15.	ledge	A squirrel sat on the window ledge and looked inside.
16.	sphinx	The famous Egyptian sphinx has a lion's body and a man's head.
17.	oblige	To oblige a friend is to do him a favor.
18.	convoy	Eight destroyers formed a convoy to protect the aircraft carrier.
19.	gorge	Sometimes we gorge ourselves at Thanksgiving by overeating.
20.	surveys	Surveys show that some foods taste better than others.

5.5 Sentence Completion (Stimulus Phrases)

1. When I have to read ____________________
2. To me, books ____________________
3. If I didn't go to school then __________
4. I'd rather read than ____________________
5. I read when ____________________
6. I'd read more if ____________________
7. Spelling is ____________________
8. When I read out loud ____________________
9. Talking in front of the class __________
10. We have spelling in school but __________

7

6.9 Auditory Memory Test

DIGIT REPETITION
(Practice Item: 4 7)
(3) 3 5 2 9 6 1
(4) 8 3 5 2 9 4 1 7
(5) 4 8 3 7 2 5 1 7 2 6
(6) 7 2 8 3 9 4 2 9 4 8 1 6
(7) 7 9 2 6 4 5 1 5 4 7 2 1 3 8
(8) 8 5 4 7 1 6 2 3 4 7 1 5 3 9 6 2
(9) 9 2 5 8 4 1 7 3 6 3 7 1 8 2 6 4 9 5

WORD REPETITION
(Practice Item: horse, ball)
(3) cow, sand, glass
(4) chair, bell, dress, car
(5) grace, truth, worth, peace, doubt
(6) doll, train, egg, milk, coat, house

STORY: The School Concert

On December 20th, the children of the city schools held a concert in the auditorium of the high school, All the children had some part in the program. The program consisted of singing by the school choir, fancy marching, folk dancing, and finally, a Christmas play. About 620 parents and friends attended the concert. The sale of tickets brought in nearly four hundred dollars.

(a) What was the name of the story?
(b) Where was it (the concert) held?
(c) When was it held?
(d) What did the program consist of? (Get 4 memories from the child)
(e) How many people attended (went to) the concert?
(f) How much money was raised?

SENTENCE REPETITION
(Practice Item: Please come in.)
(5) My watch has two hands.
(7) Tom has lots of fun playing ball.
(9) Jane wants to build a castle in her playhouse.
(11) Betty has made a dress for her doll out of cotton.
(13) Go three blocks south, turn right, and stop at the first white house.
(15) Fred asked his father to take him to see the funny clowns in the circus.
(17) The woodpeckers made a terrible fuss as they tried to drive the young away from the nest.
(19) At the end of the week the newspaper published a complete account of the experiences of the great explorer.
(21) My baby brother wants Santa Claus to bring him a great big drum, a shiny new train, and a teddy bear.

APPENDIX C: DESCRIPTION OF TESTS NOT INCLUDED IN ANALYSES

I. Tests excluded because of incomplete data.

3.10 Gates Advanced Primary Reading Test. Session 7.

9.3 California Test of Mental Maturity. Session 3.

These tests (16, 59) were administered by classroom teachers as part of the regular testing program of the Minneapolis Public Schools, or by examiners to small groups and individuals in the parochial and suburban schools.

II. Tests excluded because only categorical scores were available.

8.3 Adjective Check List.[1] Before Session 10.

After testing a subject the psychometrist rated him by checking the appropriate space on each of 19 pairs of opposing adjectives. The checks were converted into numerical ratings from *1* to *7* according to the space checked. The adjective pairs were selected as most appropriate for young children from items used by Stevenson (58) in studying the rating by college students of experimenters. The pairs of opposing adjectives were:

unpleasant-pleasant
aggressive-defensive
adaptable-inflexible
colorful-colorless
friendly-hostile
lazy-ambitious
extrovert-introvert
immature-mature
enthusiastic-unenthusiastic
sensitive-insensitive
assertive-dependent
sociable-unsociable
affected-natural
active-passive
feminine-masculine
patient-impatient
deliberate-haphazard
unattractive-attractive
sloppy-neat

8.6 Subject Preference Questionnaire.[2] Session 8.

The subject chose from among *arithmetic*, *social studies*, *reading* and *spelling* his response to two questions: (1) "If you had to leave out one class during the day, what class would you most want to leave out?", and (2) "If you could have only one class during an especially busy day, which class would you most want to have?" From among these four subjects and *science*, *art*, music and gym he chose his response to the question, "Which of these classes do you enjoy the most?" The question was read to the child from the school program and the choices were typed on 3" x 5" cards.

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[1] Constructed by Ronald J. Johnson and Gian Jain.

[2] Constructed by Ronald J. Johnson and Susan Prindle.

10.3 Evaluation of Speech Mechanism. Session 1.

The speech clinician evaluated a child on his ability to protrude and retract his lips, protrude and retract his tongue and repetitively to produce the sylables pa, ta and ka. Characteristics of the child's bite and teeth were noted. Items included were selected from the practices of clinics and public school programs. There is no single score.

III. Tests excluded because no scores were available.

5.1 Recordings. Sessions 3 and 8.

Samples of oral speech were obtained to provide data for various language analyses. In Session 3 pictures from the Children's Apperception Test (CAT) were used as stimuli to obtain at least 50 utterances from each child. The responses were recorded using a Wollensak Tape Recorder. Typescripts are completed for some children. While these recordings can be used for analyses of variables such as length of response, rate of speech, adequacy of grammatical usage, etc. they are not of sufficiently high fidelity to be used for the evaluation of the articulation of specific sounds.

Responses to 7 Thematic Apperception Test (TAT) cards were obtained in Session 8. These were recorded on Audograph discs. Typescripts completed for all intelligible discs provide material for language and personality analyses (see Test 8.4 in Appendix C).

5.7 Written Composition. Session 11.

All classes in which subjects in this study were enrolled were given the same writing assignment by their classroom teachers, as part of their language arts work. The assignment was to write for 15 minutes on the topic, "The Most Interesting Thing That Happened to Me This Year." The assignment was given to the entire class so that the writing would take place in a familiar setting for writing rather than in a test-like child-adult situation. Various analyses of language usage and content are possible.

8.4 Thematic Apperception Test (TAT). Session 9.

The seven cards selected after consultation with child clinical psychologists[3] include the five used in the National

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[3] Drs. Jack Hafner, Murray Reed, Britton Ruebush and Robert Wirt.

Mental Health Survey (Cards 1, 2, 5, 8BM and 16) and two cards that were reported frequently to elicit responses related to feelings of isolation (Cards 14 and 17BM). The order of presentation for each subject was predetermined using a random numbers technique except that whenever the blank card appeared in position _1_ or _2_ it was presented successively as the 3rd, 4th, 5th, 6th or 7th card in order that a child would not be asked to tell a story about the blank card until he had had some experience with the procedure of the test. Sessions were recorded on Audograph discs and typescripts are available on all legible responses.

8.7 Process of Drawing-a-Man.[4] Session 9.

While the subject drew a picture of a man for the Goodenough Draw-a-Man test, the examiner recorded on a schematic human figure the point of initiation and termination of the drawing and the sequence of movements followed in the production of the drawing. This is the second use of this preliminary technique in the development of a projective device that was begun as part of an earlier study (62). The necessary concentrated work for the development of the projective device is beyond the scope of this study.

8.8 Parents' Questionnaire.[5] Session 7.

This nine-page questionnaire contains questions on background information such as parent's socioeconomic status, education, organization affiliations, on speech development and status of the child, on discipline, parental standards, symptoms of maladjustment and parent-child relationships. For its construction, literature on the relation of family attitudes and practices to child articulation and other language behavior was searched. A large number of possible questions were assembled and some original questions were written. The questionnaire was tried out with persons working on the project or at the Insittute of Child Development, and then was revised. The revision was given to a small number of mothers from a wide range of socioeconomic backgrounds. Their suggestions were incorporated into the final revision.

The questionnaire was mailed to the parents of the subjects when children who were at-grade were in the second grade. Nearly 96 per cent of the parents (all except 18) returned the questionnaire.

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[4] Constructed and revised by Ann Cleary, Susan Prindle, Susan Kisrow and Mildred C. Templin.

[5] Constructed by Susan Tiktin and Mildred C. Templin.